Exploring transformative social learning and sustainability in community based irrigation scheme contexts in Mozambique

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Aristides Baloi

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Abstract

This study set out to examine transformative social learning and sustainability in the context of community-based irrigation systems in Mozambique. These irrigation systems are socio-ecological in nature. The history of irrigation systems in Mozambique can be described in two periods: pre-Independence period (mainly the colonial period) and the post-Independence period from 1975 onwards. Most recently, the Mozambique Government has introduced a policy which supports community-based irrigation system implementation and management via irrigation associations in a move to support a shift from rain-fed farming practices to irrigation-supported farming practices amongst smallholder farmers. It is this shift in the object of activity that this study focusses on. It does this by studying learning process in the constituted irrigation associations, examining whether such learning is transformative and sustainability oriented or not, and how such learning can be further expanded and supported. Learning may occur in socio-ecological systems, but whether that learning enables transformation and sustainability of irrigation systems and the constituted associations is as yet under-explored in the Mozambique context and in the context of Education for Sustainable Development in southern Africa.

The aim of this research was therefore to understand transformative social learning within the development of sustainable irrigation practices in the context of irrigation associations and new agrarian policy development in Mozambique. To examine transformative social learning in sustainable irrigation system practices (including management practices), the study worked with three research goals, which also formed phases of the study's design:

- GOAL 1: Examine how and what transformative social learning has (or has not) emerged in existing activity systems to date (Phase 1: Activity System Analysis).
- GOAL 2: Examine how transformative social learning could emerge through expansive learning processes (Phase 2: Identification of contradictions and new solution modelling through Developmental Work Research and Change Laboratories).
- GOAL 3: Identify what opportunities exist for ongoing transformative social learning (Phase 3: Identification of absences and ongoing dialectical transformation possibilities).

The study draws on theories of Social Learning, Transformative Learning and Cultural Historical Activity Theory's (CHAT) expansive learning and formative interventionist research framework to develop insights into the learning processes. It works especially with third generation Cultural Historical Activity

Theory which provides a theory of expansive social learning and collective transformative agency formation, which I deemed most appropriate for the need to understand the transformation of farmers' activities in a collective formation such as an irrigation association. The study involved identification and examination of interacting activity systems, contradictions or dissonances in two case studies of community-based irrigation system development via the respective associations. It involved identifying existing learning, as well as engaging in formative intervention research to expand learning in two case study sites: namely the Macubulane and Massaca Irrigation Associations, located near Maputo, Mozambique in the Inkomati and Umbeluzi river basins. The Macubulane community practices a monocropping system of sugar cane plantations using sprinkler irrigation methods and the Massaca community practices a mixed cropping system growing vegetables using mainly gravity or furrow irrigation methods.

The study uses a qualitative research approach and is underlaboured by Dialectical Critical Realism which allowed for a deeper probing of ontology and transformative praxis, and transformative learning. The study used methods which included in-depth interviews, change laboratory workshops, document analysis and focus group interviews with farmers and subjects in associated activity systems. Analysis involved activity system analysis, identification of contradictions, modeling of solutions, transformative agency analysis, as well as analysis of real and nominal absences and generative mechanisms as recommended in dialectical critical realism. I used inductive, abductive and retroductive modes of inference, relying on the latter to identify further potential for transformative learning.

The study demonstrates that within the associations, transformative social learning is taking place as farmers seek to address problems and contradictions. This learning leads to the creation of new agency and capabilities by ensuring good yields and continuous improvement of management practices and social status. Learning operates through formal mediation in the irrigation system of workplace-based operation, maintenance and crop management practices (i.e. through workplace learning). Social learning occurs through collective engagement with the constraints that the association faces while applying new knowledge, introducing new technology, in the process of administration and planning of irrigation activities. Expansive learning is possible when mediated actively through formative interventions in change laboratory workshops. All three types of learning were found to be present and possible in the context of the two irrigation scheme contexts.

The main study findings are that transformative social learning is a collective object-driven process in the context of a transforming object (from rain-fed to sustainable community-based irrigation scheme

farming in this study), that can be explained from the level of generative mechanisms and associated real absences that shape nominal absences and contradictions within and between activity systems. These induce, and have potential to induce, transformative learning in irrigation systems, including the emergence of transformative agency via learning through workplace-based, wider social learning, and expansive learning interaction processes amongst subjects in interacting activity systems. Absenting absences is also crucial for extending the potential of transformative learning in irrigation associations. The study further shows how critical realism helps to interpret learning processes and how it strengthens the empirical findings obtained from qualitative analysis.

A key outcome of the study is a model that frames conceptualisation of transformative social learning in irrigation systems. The model and the insights gained into farmers learning around the transformation of the object of activity explored in this study have implications for wider curriculum and policy development interventions. The study therefore also makes recommendations for curriculum development and policy implementation intervention. The curriculum development recommendations are not at the level of making recommendations for new courses only, but frame how the design of new courses should take into account the wider processes of learning and change associated with the transformation of an object of activity as articulated in the study. It recommends an approach that allows for in-field engagement with contradictions and the absenting of absences (a problem-based type of curriculum) that will also allow for conceptual development and understanding of the changing object of activity (i.e. community-based irrigation scheme *practice* and *management*). The main policy recommendation made from the study is to invest more in farmer support and farmers' learning so that they can transition from rain-fed agriculture to sustainable irrigation scheme development and management via their associations.

The research contributes to knowledge production on irrigation practices; considering that substantial understandings were generated through analysis of communal irrigation scheme practice and management and its implications, especially from a transformative learning perspective. As shown in this study, transformative social learning theories are still not well understood in the context of irrigation system development, and this study has contributed knowledge to this field. The study contributes towards understanding of sustainability learning in irrigation associations in terms of concepts and practices. The study offers a model for transformative social learning in irrigation scheme development and suggests an expanded curriculum for community-based irrigation association practice and management. Overall, the study contributes to an understanding of transformative, sustainability oriented learning processes as support for the emergence of community-based irrigation associations.

Additionally, the study has added perspectives on how to frame transformative social learning from a CHAT and critical realist perspective in Education for Sustainable Development. The study also contributes to a growing body of scholarship in southern Africa which seeks to develop expansive, transformative social learning approaches in response to concerns experienced by communities who are reliant on natural resources and the environment for their livelihoods and well-being, and who are also seeking to emerge out of poverty.

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Dedication

I dedicate this thesis to all who are working to ensure food security globally.

Table of Contents

Abstract i

Acknowledgements v

Dedication vii

List of Tables xiv

List of Figures xvi

List of Acronyms xviii

CHAPTER ONE

Introduction and Orientation to the Study 1

1.1 Introduction 1

1.2 Motivation for the study 1

1.3 Irrigation in Mozambique 3

1.3.1 Brief history of irrigation in Mozambique 3

1.3.2 Roles and responsibilities in the irrigation sector. 5

1.3.3 Policies and strategies relevant to irrigation development in Mozambique 7

1.3.4 Irrigation management models 11

1.3.5 Challenges of smallholder irrigation management 12

1.3.6 Factors and issues affecting irrigation scheme management 14

1.4 Research aim, goals and research questions 17

1.5 Research focus and design 18

1.6 Research sites 20

1.6.1 The Macubulane research site in the Incomati Basin 20

1.6.2 The Massaca research site in the Umbeluzi Basin 23

1.7 Concepts 27

1.7.1 Irrigation system 27

1.7.2 Social learning 28

1.7.4 Irrigation and sustainability 31

1.7.5 Learning and sustainability 33

1.8 Thesis structure and outline 36

CHAPTER TWO

Theoretical Framework – Social Learning, Transformative Learning and Critical Realism 39

2.1 Introduction 39

2.2 Social learning 40

2.2.1 Social learning concepts 40

2.2.2 Social learning in the context of water resources management 44

2.3 Communicative learning 45

2.4 Transformative learning 47

2.5 Critical realism 49

2.5.1 Critical realism: History and dimensions of relevance to this study 49

2.5.2 Key tenets of critical realism 52

2.5.3 Domains of reality 53

2.5.4 Causal powers 55

2.5.5 Causal explanation 556

2.5.5 Dialectic critical realism 58

2.6 Synthesis 65

CHAPTER THREE

Methodology and Cultural Historical Activity Theory 67

3.1 Introducing the overall study design 67

3.2 Case study research, case study framing, and specificities of each case 68

3.2.1 Some general perspectives on case study research relevant to this study 68

3.2.2 Case study framing in this study 70

3.2.3 Actual case study site descriptions to show the configuration of the social-ecological system, and stakeholders and participants involved in the study 72

3.2.4 The two cases 78

3.3 CHAT and expansive learning (basis for Goal 1 and 2) 79

3.3.1 Cultural Historical Activity Theory – its development over time 80

3.3.2 Expansive learning as a form of interventionist research 85

3.4 Data collection 88

3.4.1 Document analysis 88

3.4.2 Interviews: Semi-structured interview and focus groups 89

3.4.3 Change laboratory workshops 95

3.4.4 Observation 99
3.5 Analytical framework for Goal Three 102
3.5.1 Social learning analytical tools 102
3.5.2 Inductive and abductive inferences 104
3.5.3 Critical realism analytical tools..... 104
3.6 Validity and credibility..... 109
3.7 Ethics and the role of the intervention researcher..... 111
3.8 Synthesis..... 114

CHAPTER FOUR

Case Study One: Learning in the Macubulane Irrigation Association 115
4.1 Introduction..... 115
4.2 Dynamics in the activity systems in Macubulane irrigation association..... 115
4.2.1 The activity system concept 115
4.2.2 Framework for identifying, describing and analysing learning in irrigation activity systems..... 117
4.2.3 Activity systems and activity system dynamics in the Macubulane irrigation association..... 119
4.3 Contradictions emerging within and between the activity systems in Macubulane 132
4.3.1 Contradictions analysis..... 132
4.4 Learning of changed agricultural practices related to the new irrigation schemes 138
4.4.1 Motivation for learning in irrigation farming..... 138
4.4.2 Learning processes 140
4.4.3 Who is shaping or influencing the farmers' learning and how?..... 149
4.5 Potential for transformative social learning..... 150
4.5.1 Learning, cognitive transformation and social change..... 150
4.5.2 Transformation through contradictions 152
4.5.3 Building new agency..... 154
4.5.4 Relevant normative strategies for learning and transformation in the Macubulane irrigation association..... 155
4.5.5 Reflexivity 155
4.6 Synthesis..... 156

CHAPTER FIVE

Case Study Two: Learning in the Massaca Irrigation Association 157

5.1 Introduction 157

5.2 Activity systems and dynamics in the Massaca irrigation association 157

5.2.1 Introduction 157

5.2.2 Community activity system 158

5.2.3 Educators' activity system 160

5.2.4 Management irrigation committee activity system 162

5.2.5 Sellers' activity system 164

5.2.6 Shared object 165

5.3 Contradictions emerging within and between the activity systems in Massaca 166

5.3.1 Primary contradictions 166

5.3.2 Secondary contradictions 169

5.3.3 Tertiary contradictions 172

5.3.4 Quaternary contradiction 174

5.4 Learning of changed agricultural practices related to the new irrigation schemes 176

5.4.1 Motivation for learning irrigation farming 176

5.4.2 Learning processes 176

5.4.3 Social learning in the new irrigation schemes 179

5.5 Who is shaping or influencing the farmers' learning and practice and how? 183

5.6 Potential for transformative social learning 184

5.6.1 Learning and cognitive transformation and social change 184

5.6.2 Transformation through historical contradictions 185

5.6.4 Reflexivity 188

5.7 Synthesis 188

CHAPTER SIX

Expansive Learning in Irrigation Associations 190

6.1 Introduction 190

6.1.1 Locating expansive learning in irrigation associations 190

6.1.2 Preparation for and process of the Change Laboratory Workshops 192

6.2 Expansive learning in the Macubulane irrigation association 193

6.2.1 Brief summary of the process 193
6.2.2 Concept re-configuration in the Macubulane irrigation association 194
6.2.3 Identification of contradictions 197
6.2.4 Reflecting on responses to the contradictions 199
6.2.5 Potential for transformative social learning in the Macubulane irrigation association 202
6.2.6 Expanded agency in Macubulane irrigation association 204
6.2.7 Zone of proximal learning in Macubulane irrigation association 209
6.3 Expansive learning in the Massaca irrigation association 210
6.3.1 Brief summary of the process 210
6.3.2 Reconceptualisation of community-based irrigation system management in the Massaca irrigation association 211
6.3.3 Identification of contradictions in the Massaca irrigation association 214
6.3.4 Potential for transformative social learning in the Massaca irrigation association 215
6.3.5 Expanded potential for new activities 219
6.3.6 Expanded agency in Massaca irrigation association 221
6.3.7 Zone of proximal learning in Massaca irrigation association 225
6.4 Synthesis 226

CHAPTER SEVEN

Concluding the Study: Transformative Social Learning and Sustainability in Community-Based Irrigation Scheme Development in Mozambique 228

7.1 Introduction 228
7.2 Absences in the existing social learning processes and irrigation practice contexts 229
7.2.1 Nominal absences observed in the co-management irrigation systems 231
7.2.2 Real absences identified in the two case contexts 235
7.3 Engaging contradictions and absenting absences via dialectical praxis formation: processes of transformative social learning 237
7.4 Potential for transformative social learning in terms of sustainability 245
7.5 Generative mechanisms shaping transformative social learning potential in irrigation systems 252
7.6 Reflecting on dilemmas of learning and agency in irrigation associations 260
7.7 Towards a model of transformative social learning in irrigation associations 263
7.8 Curriculum and policy development recommendations to strengthen potential for furthering transformative social learning in community-based irrigation scheme development 268
7.8.1 Curriculum development recommendations 268

7.8.2 Policy recommendation 275
7.9 Conclusion.. 275

References.. 280

Appendices 295

List of Tables

Table 1.1: Remarkable events in irrigation developments 4

Table 1.2: Irrigation management models 11

Table 1.3: Advantages and disadvantages of irrigation systems 12

Table 1.4: Sustainability as interpreted in the context of irrigation system development 32

Table 2.1: Concepts of social learning 41

Table 2.2: Theories and concepts associated with social learning in participatory natural resources management 43

Table 2.3: Domains of reality 55

Table 3.1: Research design 67

Table 3.2: Entities involved in socio-ecological systems 72

Table 3.3: Water quality measured at Incomati river basin water intake to Macubulane field 73

Table 3.4: The water quality of the Umbeluzi River basin 76

Table 3.5: Crops grown at the Massaca irrigation association 78

Table 3.6: Methods and analysis 88

Table 3.7: Documents gathered for analysis 89

Table 3.8: Inquiry, contextual profiling, activity system, Change Laboratory workshops 92

Table 3.9: Inquiry for Feedback workshop 95

Table 3.10: Overview of interviews and Change Laboratory workshops at Macubulane 97

Table 3.11: Overview of interviews and Change Laboratory workshops in Massaca 98

Table 3.12: Observation methods used 101

Table 4.1: Features of the theories of motivation 139

Table 4.2: Required irrigation practices for farmers 142

Table 4.3: Social learning components (i.e. generative mechanisms) identified in Macubulane irrigation association 147

Table 4.4: The types of learning identified in the Macubulane irrigation association 148

Table 4.5: Changes in the Macubulane irrigation association (cognitive, social, and normative) 151

Table 5.1: Courses or learning programmes offered to producers in the irrigation association 161

Table 5.2: Farmers' abilities and knowledge of irrigation farming 178

Table 5.3: Social learning components (i.e. generative mechanisms) identified in Massaca irrigation system 182

Table 5.4: Changes in the Massaca irrigation association (cognitive, social, and normative) 185

Table 6.1: Programme of the Change Laboratory Workshop in Macubulane 194

Table 6.2: Framework for contradiction analysis and response 200

Table 6.3: Expressions of transformative agency identified in the Macubulane community-based irrigation association 205

Table 6.4: Framework for contradiction analysis and response in Massaca irrigation association 216

Table 6.5: Expansive learning suggested actions with responsibilities ascribed to different actors with a role to play in the formation of the expanded / new form of activity 221

Table 6.6: Expressions of transformative agency identified in the Massaca irrigation association 222

Table 6.7: Zone of proximal development in Massaca irrigation association 226

Table 7.1: Absences interpretation in both irrigation systems 232

Table 7.2: Summary of the dialectical transformative social learning process as identified across the case study sites 239

Table 7.3: Interpretation of generative mechanisms 254

Table 7.4: Summary of a polysemic framework for transformative social learning in irrigation systems 265

Table 7.5: Curriculum framework for associative and community-based irrigation system development 274

List of Figures

Figure 1.1: Research design showing phases of the research 19

Figure 1.2: Map of the Magude district 20

Figure 1.3: Incomati River Basin 22

Figure 1.4: Water discharges at Magude station 23

Figure 1.5: Boane district 24

Figure 1.6: Umbeluzi Basin sub-catchment U12, Pequenos Limbobos, where the irrigation system is installed 25

Figure 1.7: Water discharges at Goba Station 1943-2015 26

Figure 1.8: Hydrogeology of the Umbeluzi Basin 26

Figure 3.1: Map of Macubulane irrigation systems 74

Figure 3.2: (a) Measuring water quality (b) A sugar cane plantation in Macubulane 75

Figure 3.3: Massaca irrigation association 77

Figure 3.4: a) Vygotsky's model of mediated act, and b) its common reformulation 81

Figure 3.5: Structure of the human activity system 81

Figure 3.6: Two integrating activity systems as a minimal model for third generation activity theory 84

Figure 3.7: Expansive learning cycle, with learning actions 1–7 outlined 86

Figure 3.8: Interview with Macubulane association member 90

Figure 3.9: Participants in one of the focus groups, Macubulane irrigation association 91

Figure 3.10: Change Laboratory workshop in Massaca irrigation association 99

Figure 3.11: Crop production observed in field of Massaca irrigation association 100

Figure 3.12: Example of an observable contradiction in Massaca irrigation association: A defect in maintenance of irrigation system 100

Figure 3.13: Observing learning activities among farmers 101

Figure 3.14: Observing activities in the field (extensionist monitoring activities in Massaca irrigation association) 102

Figure 3.15: Social learning model 103

Figure 4.1: The structure of learning activity 116

Figure 4.2: Representation of Irrigation Management Board Activity System 120

Figure 4.3: Representation of the educators' activity system 124

Figure 4.4: Representation of the community activity system 127

Figure 4.5: Representation of the sugar company activity system 130

Figure 5.1: Representation of the community activity system 158

Figure 5.2: Representation of educator's activity system 160

Figure 5.3: Representation of the management irrigation committee activity system 162

Figure 5.4: Representation of sellers' activity system 164

Figure 5.5: Shared object in Massaca 165

Figure 5.6: Observable disturbances due to inadequate weed management. Invasive plants compete with the crops and affect production 170

Figure 5.7: Observable disturbances related with poor maintenance and water supply to the field, affecting crop production 171

Figure 6.1: Irrigation association object 197

Figure 6.2: Prototype of collective transformation in the Macubulane irrigation association 204

Figure 6.3: Zone of proximal development in Macubulane 209

Figure 6.4: Object of the Massaca irrigation association 213

Figure 7.1: Bhaskar's dialectical model of transformative praxis 239

Figure 7.2: System of addressing contradictions and absenting absences in a zone of proximal development for community-based irrigation scheme development in Mozambique 244

Figure 7.3: Framework of transformative social learning 266

Figure 7.4: Learning context in irrigation system 278

List of Acronyms

CHAT	Cultural Historical Activity Theory
CIDAE	Centre for Integration and Agribusiness Development
CLW	Change Laboratory Workshop
DNHA	National Directorate of Agrarian Hydraulic
DWR	Development Work Research
EEASA	Environmental Education Association of Southern Africa
ESD	Education for Sustainable Development
ESE	Environment and Sustainability Education
FAO	Food and Agriculture Organisation
GAPI	Sociedade de Investimento (financial institution in Mozambique)
GoM	Government of Mozambique
HEI	Higher Education Institutions
IAPP	International association for Public Participation
INIR	National Institute for Irrigation
MADER	Ministry of Agriculture and Rural Development
MICOA	Ministry of Environmental Affairs
MTS	Currency in Mozambique (metical)
MUIB	Management Unit of Incomati River Basin
NDW	National Water Authority
NRM	Natural Resources Management
PEDSA	Strategic Plan for Agricultural Development (2010-2019)
PIM	Participatory Irrigation Management
SIDAE	District Service of Economic Activities
UEM	University of Eduardo Mondlane
UN	United Nations
UNDP	United Nations Development Programme
WUOs	Water user organisations

CHAPTER ONE

Introduction and Orientation to the Study

1.1 Introduction

This chapter presents the scope of the research that aims to investigate transformative learning that emerges (or potentially may emerge) from community irrigation management processes in Mozambique. This chapter describes my motivation behind this study and through this, provides insight into my positioning as a researcher and educator involved in the study areas. It further describes the history of irrigation development in Mozambique, with a focus on community based irrigation management, policies and institutional frameworks, as this is the interest focus of this study. The chapter also describes the research sites and the hydrological conditions of the Umbeluzi and Incomati catchments in Southern Mozambique, where the irrigation schemes that form the focus of the expansive learning case study research in this dissertation, are located. Also presented in this chapter are the research questions, goals and the key concepts that are of relevance to the research. The chapter concludes with an outline of further chapters in the thesis.

1.2 Motivation for the study

The basis of my interest in educational irrigation community learning and environmental sustainability has a link with my professional background in Mozambique. After studying Geography at a university in Ukraine (1991-1996), I was selected to become a Geography lecturer in Maputo city at the University of Eduardo Mondlane (UEM). This was the start of my professional journey in the area of focus relevant to this study, which includes not only giving attention to community learning, but also wider educational activities related to teaching, curriculum development and research.

I started lecturing Hydrology and later Environmental Education and the fundamentals of landscape geography. In the process of teaching Hydrology as part of the Geography course, I focussed on issues associated with water circulation and its components, which include water balance, runoff, groundwater, and water quality. Since Geography is concerned with society and environment, this dialectical focus of society-environment relations furthered my interest in the link between water and growth or development. This study is not a geographical or an economics study, but it focuses on the issues of multiple uses of water related to socio-economic activities and environmental and income-related needs. It does this, however, from an educational, and educational research perspective, which provides a means of engaging the related social-ecological and educative dynamics of the concepts and case contexts employed in this study.

As an academic researcher, I have engaged with activities associated with irrigation and food production in the Umbeluzi and Incomati catchments. Here I met water managers and discussed the process of water data systems, water uses (mainly for irrigation), interactions with farmers, catchment features in terms of drainage systems, geology, vegetation, soils, groundwater use in the surrounding communities, and water quality. This furthered my interest in the topic. The issue of water circulation and use is becoming a matter of high concern in the educational context in Mozambique, since the country is well drained and there is a need to build capacity around water use and management. Water is used for many purposes, including supplying, plant generation, and ecosystem conservation. Issues of water have become a priority in learning and research institutions where water supply, demand, water access, water quality, and water scarcity are topics of concern.

In 1999, I had the opportunity to go to the Netherlands for a master's course on Water Resources Management. This Masters in Engineering provided me with the possibility to deal with water concerns in a practical way. With the knowledge gained, I improved my teaching activities and research in my current position as university lecturer, and through this I became actively involved in research and education activities related to water policy and strategy development in Mozambique.

In 2001, I became involved in a research programme in water management in a river basin that was developed by the former Land Tenure and Water Development Centre in Mozambique. The study focussed on water access and management practices at Umbeluzi Basin under Basis Research Project in 2001. The research was developed in the Boane district, focusing on water access and irrigation. It was through this research programme, that I developed a deeper interest in irrigation and I became interested particularly in understanding how local communities handle knowledge on running complex irrigation systems to ensure efficiency of water use and irrigation system management.

In Mozambique, the setup of irrigation schemes is a new policy priority as they are necessary for attaining food security and poverty alleviation objectives (see section 1.3 below). The intention of the government is to move communities from rain-fed to irrigation-led production to improve productivity, but also to mitigate climate variability effects. The communities are expected to be involved in all stages of irrigation development, including the process of management. Irrigation systems in Mozambique are run by public institutions, communities, private companies, or a mixture of these. As shown in this study and in my research questions (see section 1.4), my interest is in community-led irrigation systems, where communities themselves play a role in leading all processes of managing the irrigation system.

Under recent curriculum reform at my institution (the UEM), the subject of Environmental Education was introduced into the Geography curriculum. I teach this subject. Comprehensive Environmental Education is concerned with ecological and social issues in learning contexts. As explored in this study, I consider irrigation systems to be constructed of complex ecological and social issues that can be interpreted through knowledge interactions and learning processes.

1.3 Irrigation in Mozambique

This section describes the history of irrigation development in Mozambique and as such it provides the background to the study, which focuses on social learning and community-based irrigation management (see section 1.4 below). It begins with brief history of irrigation systems, and then explores various roles and responsibilities within the irrigation sector. The section also introduces relevant policies and strategies, and provides insight into how irrigation management is conceptualised and classified.

1.3.1 Brief history of irrigation in Mozambique

The history of irrigation systems in Mozambique can be described in two periods, inclusive of the pre-Independence period (mainly the colonial period) and the post-Independence period from 1975 onward.

Pre-independence period

According to the Irrigation Strategy of the Government of Mozambique, irrigation in the pre-colonial period had some importance in terms of being an incentive for the rural economy of the colonial settlers, mostly in the southern Mozambique river basin in the case of the Limpopo and Incomati Basin (Government of Mozambique [GoM], 2013). For example, from 1950 to 1960 irrigation infrastructure was established in the Limpopo Basin in the form of the Chokwe Irrigation system, which attracted colonial peasant settlers (Valá, 2006). This irrigation system was used from 1961-1974. According to Valá (2006), the rural extension services in the Limpopo settlements were framed by a commodity based approach, where a technical brigade forced the farmers to produce rice in an irrigation system. However, the culture of rice was unknown among Portuguese settlers and Mozambican people, so an extension system was implemented to deliver technical assistance to farmers and adhere to the objectives defined by the colonial government during that period.

Extension services were designed to function via irrigation associations, for example, in the Limpopo Irrigation association, extension services were appointed to supervise the channel's hydraulic infrastructure, control the process of irrigation and drainage, and guarantee the appropriate use of hydraulic infrastructure considering irrigation functioning guidelines. During this period, there was a relation between research and extension, but this was oriented towards the interests of the colonial state (ibid.). Research was undertaken in the local agrarian station, which had connections with the agrarian college and technical extension brigade. In this period, irrigation mostly benefitted colonial farmers with most local farmers excluded from irrigation practices or programmes (ibid.), hence knowledge of, or a culture of modern irrigation practices were not developed amongst peasant farmers, or local indigenous Mozambicans.

Post-independence period

In 1975 Mozambique became independent. Post-1975 marked a new era of irrigation development as the Government of Mozambique gave priority to the rehabilitation of irrigation infrastructure and expansion of irrigation to new areas (GoM, 2013). This also included the irrigation system at Limpopo and the Incomati Basin. Table 1.1 presents some of the notable events in irrigation development in the post-colonial era.

Table 1.1: Remarkable events in irrigation developments

Year	Process	Institution	Deliberation
1976	Development of a general plan of hydraulic infrastructure, including irrigation systems	Ministry of Public Works / Directorate of Hydraulics Services	Projection of rehabilitation and infrastructure development for 1977 to 1986
1979	Institutionalisation of State Secretariat for Limpopo and Incomati region (SERLI)	Ministry of Agriculture	Infrastructure rehabilitation in Incomati and Limpopo areas
1983	Termination of SERLI and Institutionalisation of State Secretariat for Agriculture Hydraulics (SEHA)	Ministry of Agriculture	Infrastructure rehabilitation in Incomati and Limpopo areas
1980	Institutionalisation of Provincial Hydraulic Unities	Ministry of Agriculture	Development of small scale irrigation systems

1991/1992	Creation of Coordination Cabinet of Integrated Project (GCPI)	Ministry of Agriculture	Support of small scale irrigation
1995	Termination of SEHA and institutionalisation of National Directorate of Agrarian Hydraulics (DNHA)	Ministry of Agriculture	Provisions made for irrigation systems
2005	Termination of DNHA and institutionalisation of Department of Hydraulic Engineering under actual National Directorate of Agrarian Services	Ministry of Agriculture	Provisions made for irrigation systems
2006	Creation of Agrarian Fund for agrarian development from integration of FDHA and FFA	Ministry of Agriculture	Support to farmer activities
2013	Launched National Strategy for Irrigation	Ministry of Agriculture	Action for expansion of irrigation systems
2013	Institutionalisation of National Institute for Irrigation (INIR)	Ministry of Agriculture	Provision made for irrigation systems

Source: Author

According to the National Irrigation Strategy of 2013, development of, and policy related to small scale irrigation systems was established in 1990, when the Province Irrigation Unities were created to support the development of small scale irrigation systems by providing hydro-farming extension services and capacity building. In 1995 the National Directorate of Agrarian Hydraulic (DNHA) was created by the Ministry of Agriculture and Fisheries under the Ministry of Agriculture and Rural Development (MADER). This ministry was discontinued in 2005, when the Ministry of Agriculture (MINAG) was formed. This resulted in the termination of the DNHA and the creation of the Department of Hydraulic Engineering and Irrigation Systems Management within the National Directorate of Agrarian Services (GoM, 2013).

The most relevant achievement in this period was the development, in 2013, of the National Institute for Irrigation (INIR) which resulted from implementation of the recently approved National Irrigation Strategy (GoM, 2013) in the same year.

1.3.2 Roles and responsibilities in the irrigation sector

As noted above, and in Table 1.1, in 2013 the National Irrigation Institute (INIR) (resolution n2/2013) was created by the Government of Mozambique. The objectives of the INIR, which falls under the Ministry of Agriculture are to:

a) Frame strategies, norms and rules for sustainable hydro-agriculture;

b) Promote irrigation agriculture; and
c) Develop studies for the use of land and water for irrigation proposes. (GoM, 2013)

The INIR has competencies that include:

a) Supporting the establishment of producer organisations for irrigation system management and supervise its supervision;
b) Promoting the rehabilitation, construction, operation, and maintenance of the hydro-agrarian infrastructure;
c) Developing and promoting scientific activities and technologies regarding irrigation systems;
d) Being involved in public and private partnerships for the management of irrigation systems; and
e) Adopting sustainable measures to mitigate the environmental impacts of hydro-agrarian activities. (ibid.)

Within the Ministry of Agriculture, the National Extension Directorate also plays a relevant role and is responsible for promoting and evaluating irrigation development within normal sector-based dissemination of agrarian technologies. However, it is not only the Ministry of Agriculture and its institutes and departments that have a role to play in irrigation establishment and management in Mozambique. There are a range of other stakeholders with diverse responsibilities, all of which are potentially important for social learning and irrigation scheme management. I highlight their roles briefly below:

- The National Directorate of Water, under the Ministry of Public Works and Housing, is responsible for water management planning and water policy development regarding use and access of water, for example, for irrigation and edification of irrigation infrastructure for storage, protection against floods, and roads for accessing production.[1] The National Directorate of water is also responsible for supply of water and sanitation services at national level. Their role is also to ensure that ground and surface water resources are used appropriately. Under new policy and decentralisation of the water sector, this directorate is separated into five Regional Water Administrations (ARAs).[2] The Incomati River falls under ARA-Sul, which has the responsibility to guarantee water availability to, for example, the irrigation sector, to create a water use register and to collect water fees.

[1] BR I Serial – NR 28 11 June 2012

[2] Ibid.

- The Ministry of Education is responsible for education in terms of development of technicians and researchers for irrigation activities and related capacities. This includes responsibility for educational institutions that develop curricula that addresses irrigation issues.

- The Ministry of Environmental Affairs (MICOA) is responsible for environmental policies and all issues of licensing of irrigation projects. Its other responsibility is to ensure compliance with regulations that contribute to environmental sustainability. The Directorate of Environmental Impact Assessment is responsible for licensing for developments, while the Directorate of Environmental Management is responsible for environmental awareness.

- The Ministry of Energy is responsible for the development of hydropower and supports power supply to hydro-agricultural projects.

- Private institutions, such as AgriBanks and machinery suppliers, are also relevant to irrigation development in terms of providing credit and equipment for irrigation development.

1.3.3 Policies and strategies relevant to irrigation development in Mozambique

All the institutions and stakeholders above are required to work within the national policies that govern irrigation practices and developments. These include the National Irrigation Strategy; the National Green Revolution Strategy for Smallholder Farmers; the PEDSA Strategic Plan for Agricultural Development; Water legislation; and National Environmental Law. These are introduced briefly below:

- **The National Irrigation Strategy** (GoM, 2013) defines three important players in the irrigation sector namely (i) the small scale producers (ii) the private sector, and (iii) the public agrarian services. One of the key achievements of the new irrigation strategy is that it encourages smallholder irrigation producers and considers them key actors in the irrigation sector. The responsibility of small scale producers is to practise irrigation farming by ensuring higher yields that also guarantee water efficiency use in irrigation systems. This implies that farmers within the irrigation / farmer associations must have capabilities for efficient irrigation practice and farming. The private sector is seen as a pivotal sector in irrigation development, and has a role in practising irrigation farming at a wider scale, and in contributing to irrigation development by providing consultation services in the field of irrigation development. This sector is also expected to supply agrarian inputs and equipment, facilitate commercialisation, process farming products and stimulate the work of small producers such as in the case of the Macubulane Sugar Cane Farming association (see section 1.5 below). The public agrarian services also have responsibilities for promoting irrigation developments. Further, the national irrigation strategy mentions that irrigation services at provincial and district level should continuously support the process of planning, establishment, exploration, and monitoring of the performance of irrigation systems. In relation to this study's interest, the National Irrigation Strategy is an important policy framework, as it allows for a focus on smaller scale producers using irrigation systems.

- **The National Green Revolution Strategy for Smallholder Producers** (GoM, 2007a) includes two important pillars, namely (i) improved technology, and (ii) capacity building of human and social capital. The green revolution is based in the development of improved technologies, emphasising technology that can be adapted to the family sector, i.e. to smallholder producers. The National Green Revolution strategy aims to (i) increase cultivated areas, (ii) increase yield per hectare, (iii) consider the need to increase the use of irrigation technologies, in particular adapted to the small scale producer sector, (iv) improve and enlarge the availability of agrarian inputs, particularly improved seeds, and fertilisers, (v) develop and disseminate technologies that allow the use of sustainable natural resources, e.g. land, water, and forests, (vi) promote initiatives for inputs production and processing, (vii) revitalise production and improve seed, and (vii) revitalise and enhance institutional capacity of producer associations (ibid.). The purpose of the smallholder associations is to ensure adequate support for small scale producers and to strengthen social and capital development for agricultural production. With regard to smallholder farmer associations, this strategy seeks to ensure the following activities take place: (i) consolidate legal-political tools for the association movement and support production (ii) provide an adult learning programme, considering that many peasants still need to learn how to read and write in order to develop their activities, as Mozambique's literacy level is low, (iii) participate in the construction, management and maintenance of small irrigation systems, (iv) create credit solidarity groups and other forms of savings, (v) facilitate research processes and evaluation and validation of technology, (viii) facilitate capacity building programmes, (ix) support adoption of appropriate technologies, and (x) contribute to the dissemination of technology.

- **The Strategic Plan for Agricultural Development (2010-2019) (PEDSA) (GoM, 2010)** established by the Ministry of Agriculture addresses the need for synergies in order to transform this sector from subsistence rain-fed low productivity to more competitive agriculture. In order to improve water availability and management for agriculture and livestock production, the strategy sets out to (i) improve actor's knowledge through increasing support to training institutions and agricultural extension systems, including development of knowledge in management irrigation schemes, (ii) promote the improvement of use of irrigation technologies with rain water, (iii) improve water management and mitigate climate change risks, (iv) enhance and rationalise the institutional framework to support farmers in irrigation, (v) consider the need to build and rebuild the irrigation system and drainage, (vi) improve capacity of the actors across the whole value chain (e.g. farmers, processors of the products, and traders) to participate in markets, (vii) increase the credit lines for agricultural enterprises, (viii) create financial opportunities for youth farmers, (ix) promote a tri-party model of credit involving (banks, producers and agro-industry) to ensure minimum risk, (x) promote agricultural insurance, and (xii) support agricultural credits and beneficiaries of District Development Funds with technical information for development of agrarian enterprises. Relevant to this study, the PEDSA strategy also seeks to increase awareness, theoretical and technical knowledge on co-operative management of agriculture and irrigation scheme development.

- **Water legislation** is also important for irrigation system development. Here the national Water Law No. 16/91 expresses principles and main strategies for water management in Article 7. It outlines institutional coordination, competences and regulations for the water sector. Relevant to this study the law defines that water irrigation users must develop effective water use approaches and develop adequate measures to reduce water loss and wastage. Article 46 indicates that beneficiaries of irrigation systems must use water in an intensive and efficient manner, and value the water available. The law differentiates between two types of water use, namely common use and private use. Relevant to this study, water in the context of common use is consumed by families for domestic purposes, livestock and small scale irrigation.

- **The National Water Policy (GoM, 1995)** is also relevant to irrigation system development as it seeks to guarantee the attainment of sustainable water supply and sanitation. Regarding agricultural water management in the policy, it indicates that the government will promote private sector participation to obtain full benefit from existing irrigation and hydroelectric schemes; and that conditions should be created for the attraction of private investment to make full use of the existing investments in dams for irrigation and electricity generation, and to rehabilitate small water impoundments. The Food and Agriculture Organisation (FAO) reported that the private sector could participate in the rehabilitation and extension of irrigation systems and the rehabilitation of small works as part of integrated rural development programs (FAO, 2005, p. 403).

- **The National Water Resources Management Strategy (GoM, 2007b)** was designed to facilitate implementation of the National Water Law mentioned above. It underlines the need to fulfil the basic need of water supply for human beings, improve sanitation, and improve efficient use for economic development, conservation developments, flood reduction and drought, peace and regional integration and guarantee water resources for the development of Mozambique. The guiding principle for irrigation is that water supply should be guaranteed in an adequate quantity at the national level to allow the continuing development of small and large irrigation projects (GoM, 2007b). This is meant to benefit smallholder producers and, thus, guarantee food security, increase family revenue and create labour opportunities.

- In addition to national water legislation, also important to irrigation management is the **National Environmental Law** 20/97 (GoM, 1997). This law establishes the basic principles of environmental management and considers the protection of environmental commons, particularly the ones with cultural and historical relevance; the protection of biodiversity; establishment of conservation areas; and includes legislation governing the development of infrastructure in fragile environments). The National Environmental Law defines tools for environmental management, including environmental licensing, environmental impact assessment, environmental auditing, and outlines responsibilities for environmental monitoring (ibid.).

In most case laws are developed, for example laws regarding access and use of natural resources and conservation. Policy and strategy are defined to guide action for implementation in relation to specific laws. The range of policies and strategies mentioned above recognise the following:

- The need to shift from rain-fed farming practices to irrigation system farming practices,
- The need to increase productivity and ensure food security,
- The need to provide knowledge to farmers,
- The need for farmers to organise in associations as this will allow them more access to extension services and farming resources, and
- The need for efficient use of natural resources.

These policy intentions provide the rationale behind and motivate for the need for learning in irrigation systems. They also require reflection on educational processes related to the introduction of the policy framework.

1.3.4 Irrigation management models

Related to the legislative framework described above that governs irrigation management, is the concept of irrigation management classification, which affects irrigation management practice in Mozambique. In resolution 10/2010, the Government of Mozambique noted that an appropriate classification of irrigation system management is considered an important factor. This deliberation approves the models of irrigation system developed in Mozambique. The resolution classifies four models of irrigation management, as presented in Table 1.2.

Table 1.2: Irrigation management models (GoM, 2010b)

Irrigation management model	Features
Model 1	Management by individuals or associations of small irrigation systems up to 100 hectares. In this system, the state supports smallholder producers with technical capacity, as well as facilitating fund raising and marketing to improve the use of the irrigation system
Model 2	Management by public entity, applied to large irrigation systems with complex land issues, where the state builds the system and the management is done by governmental organs
Model 3	Management by concession to private companies or associations
Model 4	Combined management

The Macubulane and Massaca irrigation associations, which form the focus of this study, fit into model 1 as described in Table 1.2 above. In the Macubulane case the infrastructure was subjected to rehabilitation and renewal (i.e. modernisation of older systems), while in Massaca the irrigation infrastructure was newly constructed. In both cases, associations were formed to run the respective irrigation systems (see section 1.5 in this chapter).

1.3.5 Challenges of smallholder irrigation management

One of the challenges in smallholder management is to ensure efficient use of water, considering that water is an economic good (or common pool resource as described by Ostrom, 1990) and it is scarce resource. The association should be able to operate in a way that guarantees the maintenance of the system, and that ensures water availability and supply for all needs in the system, and to guarantee water quality. Moreover, the smallholders involved in the irrigation systems should be able to produce crops that achieve standard yields per hectare in the irrigation system, ensuring also high quality products for market distribution. Additionally, the irrigation smallholders should know how to work together as a group and cooperative rules should be developed to mediate the process of management.

Knowledge is required in different fields, such as technical knowledge in terms of the mechanics of the system, crop management, finance, soil management, water management, human resources, and policy and legislation. Literacy development is also important in order to actively involve the farmers in the process of management. The farmers should also be able to deal with uncertainties, ecological concerns, and marketing or financial aspects that arise during the process of management of the irrigation system. As explained above, environmental risk and uncertainties in Mozambique can be linked to climate change/variability issues which pose additional knowledge and uncertainty challenges for smallholder irrigators.

Another area of knowledge concern for smallholder irrigators and irrigation system managers, is knowledge of different ways of applying irrigation water. In Mozambique, typically three different irrigation practices are used. Firstly, with surface (or flood) irrigation the entire land surface is made wet. Secondly, with the sprinkler method the soil is made wet in much the same way as rain does. Thirdly, with localised irrigation water is applied to each individual plant almost daily.

The surface method can be divided into: (a) surface border strip method, which makes use of parallel ridges to guide a sheet of flowing water as it moves down a slope; (b) surface check basin irrigation, which involves dividing the field into smaller units, so that each has a nearly level surface; (c) surface furrows method, which is used to irrigated crop rows, with furrows developed between the crop rows in the planting and cultivating process; and (d) subsurface method in which the sub soil is fully saturated and only certain parts of the ground level are wetted. Each irrigation method has advantages and disadvantages as outlined in Table 1.3 below.

Table 1.3: Advantages and disadvantages of irrigation systems (Chandy, 2013)

Irrigation method	Advantages	Disadvantages
Surface border strip method: makes use of parallel ridges to guide a sheet of flowing water as it moves down a slope	• Easy to construct border ridges, even in simple farm implements like a bullock-drawn A-frame or tractor-drawn disc ridger • Labour requirement is greatly reduced compared to the conventional basin method • Uniform distribution and efficient high water application when the system is properly designed • Large irrigation streams can be used efficiently • Operation of the system is simple and easy • Adequate surface drainage is provided if outlets are available	• Requires extensive land grading • Mainly suitable for deep soils with availability of large flow of water • Drainage may be essential • Water wastage
Surface check basin irrigation: involves dividing the field into smaller units so that each has a nearly level surface	• The entire area is not flooded, thus ensuring high water use efficiency • Excessive seepage loss can be avoided • Damage to plant and loss of soil nutrients does not occur	• Ridges interfere with the movements of tractors, drawn for intercultural operation or harvesting • Considerable amount of land is occupied by ridges and field channels thus crop yield is substantially reduced • The methods impede surface drainage • Labour required for land preparation and irrigation • Precise grading and shaping are required
Surface furrow method: is used to irrigate of rows of crops with furrows developed between the crop rows in the planting and cultivating process	• Water in furrows contacts only half to one fifth of surface, thereby reducing evaporation and crusting of the soil • Reduced labour requirements in land preparation and irrigation • No wastage of land in field ditches, compared to check basin irrigation	• Requires skilled labour to operate • May cause serious erosion • Difficult to use mechanical operations

Sub-surface	• Useful for soils with low water capacity and high infiltration rates, where surface methods or sprinklers cannot be used • Evaporation from ground surface is minimum • It is possible to maintain the water level at optimum depths for crops as required at different growing stages	• Quite expensive and labour intensive in the beginning • Requires an unusual combination of natural conditions, thus its scope is limited • Frequent removal of accumulated soil and materials from channels is necessary
Sprinkler	• Enables utilisation of even a small water flow of undulated lands and soils with shallow depths • It saves 10-16% land as well as relatively less permeable soils and can be easily irrigated without any risk of run-off and erosion, inundation and seepage losses • Fertilisers, pesticides and weedicide can be applied along with water spray, thus saving extra labour	• High initial cost of equipment • Operating costs are generally higher than surface methods • Wind disturbs the sprinkler, giving uneven distribution of irrigation water • Sprinklers contain an appreciable amount of salts, which may result in burning or death of plants • Under certain climate conditions diseases may be encouraged
Localised drip irrigation, also called the trickle method: involves the flow application of water to the root zone of the crop	• Suitable for vegetable and orchard crops, where plants are widely spaced • It can be used in sandy and undulating land • High water efficiency • A comparatively simple method	

In Mozambique, the most common method of water irrigation is surface irrigation. In the Chokwe irrigation system, basin and furrow methods are used, and in Massaca, furrows are used. Macubulane started using sprinkler methods recently in their sugar cane production, and some schemes use localised drip irrigation, mainly for fruit and vegetable production.

1.3.6 Factors and issues affecting irrigation scheme management

In Mozambique, new policies (especially recent policy as outlined above) support the need to move from rain-fed agriculture to irrigated agriculture, which will improve productivity. The challenge to make this shift is huge, as 98% of farmers practise rain-fed agriculture (GoM, 2013). Additionally, in Mozambique, agriculture is an important pillar for social economic development, as almost 75% of the economy relies on agriculture. Due to the heavy reliance on rain-fed agriculture, productivity in this sector is affected by climate variation, especially rainfall variation. The significance can be further appreciated as agriculture plays a crucial role in food security; therefore, the development of irrigation systems is vital in building resilience for climate change effects and food security (GoM, 2013).

Current issues in irrigation system developments are mostly associated with physical factors of the irrigated field that include rainfall, water availability and quality, and soil conditions. Technical factors such as equipment and social factors such as labour are also of concern. The process of maintenance and operation of the systems, crop management planning and budgeting also need to be considered. In addition, and relevant to this study, the dynamic process of management may depend on the size of irrigation system, and whether the system is co-operatively or privately implemented.

In the process of irrigation development and management, specialised knowledge is required to run the system to allow efficient use of water and to maintain or sustain resources and the system itself. These issues are a challenge at the level of community irrigation systems management because of earlier exclusion from irrigation system development, and thus there is a need to equip farmers with relevant knowledge of irrigation practice and management.

The government's agriculture strategies recognise that Mozambican peasants have limited knowledge in terms of production technology and advanced farming practices.[3] Working as an association of farmers or irrigators, meaning a group of smallholders running an irrigation system, farmers are expected to deal with many issues that include the need for organisational capacity, access to credit, access to markets, and improved productivity. Factors that affect productivity include use of mainly traditional practices, manual equipment for cultivation, inappropriate seeds, and little access to fertiliser. Irrigations systems can also be described as 'common pool' resources (Ostrom, Gardner & Walker, 1994). Within the Mozambique system of community-based irrigation, it may also be difficult to exclude or limit users associated with this common pool resource once resources are provided (Ostrom et al. 1994). Ostrom, Burger, Field, Norgaard and Policansky (1999) indicated that common pool resources often face problems related to assignment of tasks related to their management, external technological problems, provisioning problems and maintenance problems. Wijayaratna (2002) pointed out some specific issues that affect irrigation and irrigation system management, including:

(i) the issues of membership, whether based in water use or land ownership, if these diverge;
(ii) the boundaries for irrigation organisations, whether administrative or hydrological;
(iii) the means for ensuring accountability of decision making of water users, as well as other stakeholders; and

[3] Strategic Plan for Agricultural Development (2010-2019) (PEDSA) (GoM, 2010a)

(iv) the enforcement of decisions and formal power of associations.

Related to, and extending the above, McIndoe (2001), Chandy (2013), and FAO (2001), have described various factors that affect the selection/design development and implication of irrigation schemes. These can be divided into physical, economic and social factors. The most significant factors, adapted from McIndoe (2001), Chandy (2013) and FAO (2001), are described below:

a) Physical factors include soils, water holding capacity of the soil, topography, wind, water supply systems that discharge water under high or low pressure, energy sources, flood risk, irrigation distribution uniformity, and water quality. In Mozambique, it is also necessary to factor in climate change impacts. Water quantity factors affecting irrigation scheme management include the potential issue of water loss due to evapotranspiration, and possible alteration in water regime change due to water abstraction and storage and water transfer from one basin to another basin. In terms of water quality, the main factor influencing irrigation system management includes water salinisation due the intensive use of fertiliser. The type of crop, and soil quality and type, also influence water usage.

b) Economic factors include initial capital cost of an irrigation system, capital investment, the annual cost of an irrigation system, economic efficiency, energy costs, labour costs, and reliability and service. In the Mozambique smallholder farmer context, there is also a need to consider issues associated with poverty and lack of adequate capital resources for ongoing technical maintenance costs, or large outlays of capital investment that might be needed.

c) Social factors can include public perception, health and safety issues, and labour skills. Additionally, in Mozambique it is also necessary to consider literacy levels and prior education and experience of farmers who have, as noted above, tended to rely heavily on rain-fed agriculture. In a community-based irrigation system management context, there is also a need to consider social and management skills, and relational histories between smallholder farmers, the government, extension services, business, and the market.

The factors mentioned above need to be considered in order to understand why Massaca irrigation association selected a gravity design for their irrigation system and why Macubulane opted for a pivot design and to understand further concerns during implementation. It is also important to take these issues and factors into consideration, to understand related competencies and requirements that are needed to ensure the sustainability of the irrigation systems in both their design and implementation. More importantly for this study's focus and interest, they might influence or relate to the learning process involved in irrigation systems management, as some or all of these current issues might be the subject of transformative social learning in community-based irrigation system management. These issues and factors may also be reflective of or related to core tensions and contradictions in the irrigation system, an aspect which I explore further in this thesis in more depth given the significance of tensions and contradictions in dialectical processes of transformative social learning (as discussed in more depth in Chapter 2).

1.4 Research aim, goals and research questions

The aim of this research is to understand transformative social learning within the development of sustainable irrigation practices in the context of irrigation associations and new agrarian policy and development in Mozambique. To examine transformative social learning in sustainable irrigation system practices (including management practices), I developed three research goals as described below, which also frame the phases of this study. Each of the goals has a set of linked research questions.

GOAL 1: Examine how and what transformative social learning has (or has not) emerged in existing activity systems to date (Phase 1: Activity System Analysis). Linked research questions:

- How do rules, mediation tools, community members, division of labour and subjects influence the learning of new irrigation scheme practices?
- How have farmers been learning changed agricultural practices related to the new irrigation schemes?
- Who is shaping or influencing the farmers' learning and how?
- Can such learning be described as 'transformative social learning', and if so why?

GOAL 2: Examine how transformative social learning could emerge through expansive learning processes (Phase 2: Identification of contradictions and new solution modelling through Developmental Work Research and Change Laboratories). Linked research questions:

- Can and how can new learning be facilitated through sharing of new knowledge and decision making amongst farmers, with support from a developmental work researcher?
- How do farmers engage with transformative practices (or not) through the social learning processes and interactions that become possible in a facilitated expansive learning cycle?

- Does the explicit inclusion of absence and negation in the expansive learning cycle stimulate transformative social learning, and, if so, how does this occur?
- What (transformative) practices are evident? How were they constituted in and through the learning processes?

GOAL 3: Identify what opportunities exist for ongoing transformative social learning (Phase 3: Identification of absences and ongoing dialectical transformation possibilities). Linked research questions:

- What absences exist in the existing social learning processes and irrigation practice contexts?
- How can these be absented through ongoing dialectical transformation possibilities?
- What potential exists for ongoing transformative social learning in the context of sustainable irrigation scheme developments in Mozambique?

1.5 Research focus and design

Irrigation systems are characterised for being complex in terms of components and interaction between those components. As indicated in the research aims and goals above, this research concentrates on social learning processes and knowledge interactions that emerge in processes of irrigation management. The study focuses specifically on irrigation systems in which producers take an active role in running most of the system activities. These producers are integrally involved in the social learning processes and irrigation practices that are required to deal with the social-ecological dialectical contradictions that arise in the shift from rain-fed to smallholder community-based irrigation system management that is oriented towards higher productivity and structured under the grant-based system outlined in model 1 of Table 1.2 above. This research therefore contemplates the social learning that is experienced amongst smallholder irrigators and the sustainability of their irrigation systems development. It also situates these practices within wider social-ecological sustainability concerns, which include the need to alleviate poverty in Mozambique, while also farming in more sustainable ways that do not degrade soils, or waste water for example. The research is interested in exploring if and how such learning can be viewed as transformative social learning or not.

The research is designed and presented as outlined in Figure 1.1 below. The study is designed in three phases as outlined above in the research goals:

- Phase 1: Examination of existing transformative (or not) social learning in irrigation activity systems (see sections 2.2, 2.3, 2.4, 2.5, 3.3.1, 3.6). This phase involved an in-depth literature review and theoretical scoping to identify relevant theoretical vantage points for understanding transformative social learning (see Chapter Two). It also involved in-depth contextual and cultural historical analysis. In this phase I worked mainly with Engeström's cultural historical activity theory (section 3.4.1) which seeks insight into learning in, and between related human activity systems, which share a common object; in this study the common object was communal irrigation practices. This phase of the research is presented as a description of the activity systems in the two case study sites in Chapters Four and Five.

- Phase 2: Expanding learning in two case study sites via Engeström's method of expansive learning using developmental work research and change laboratories (see section 3.4.2). Engeström and colleagues have produced a helpful process methodology for expanding learning that arises from contradictions in collective zones of proximal development, which I have used to guide this study. This phase of the research is presented and described in Chapter Six.

- Phase 3: Reflective review of the social learning in the two case study sites using dialectical critical realism (see sections 2.2, 2.3, 2.4, 2.5 and 3.6, 3.7) to examine if and how the learning can be viewed as transformative social learning or not. This involved considering absence and negation, and the process of collective social learning as a passage through the dialectic as described by Bhaskar (1998). This phase of the research is presented in Chapter Seven.

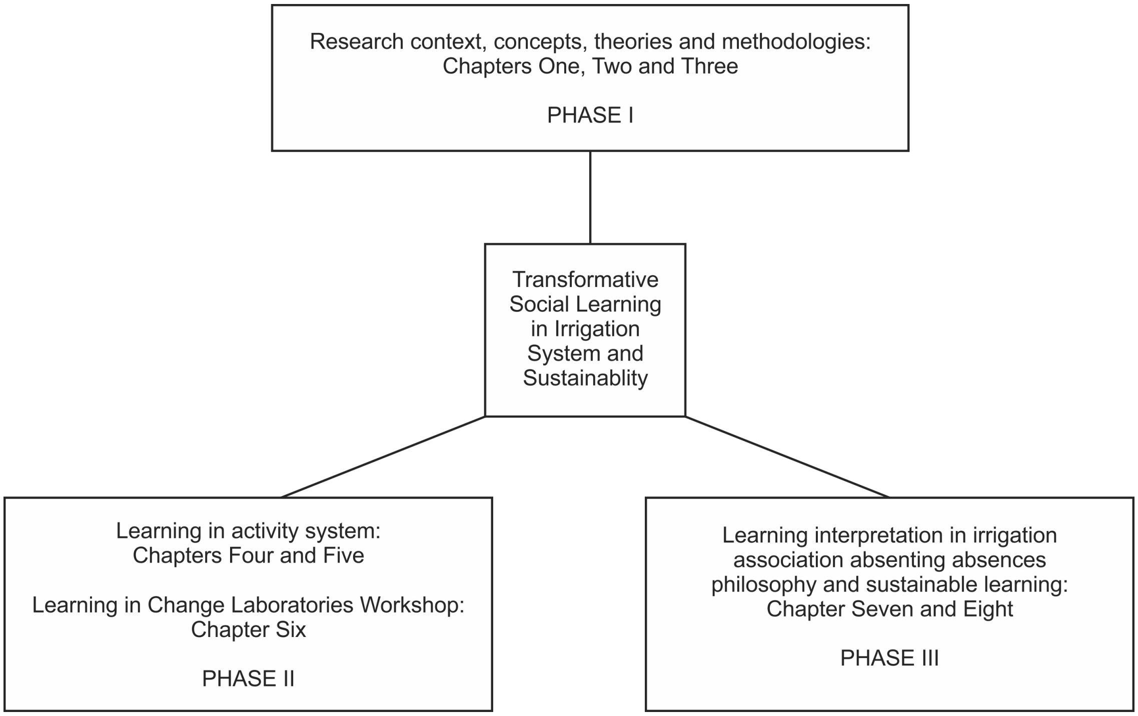

Figure 1.1: Research design showing phases of the research

1.6 Research sites

This section provides a description of the two research case study sites namely the Macubulane community-based irrigation association site in the Incomati Basin and the Massaca community-based irrigation association site in the Umbeluzi Basin. Each site is introduced below.

1.6.1 The Macubulane research site in the Incomati Basin

Climate, topography and soils

The Macubulane irrigation association and its community are located in the Magude District of Southern Mozambique in the Incomati Basin (see Figure 1.2 below). In terms of climate, this region is semi-arid, temperatures are around 26°C and the rainfall is an average of 630 mm/year. There are two predominant seasons the first 'warm' season stretches from October to March when almost 80% of the precipitation during the year is registered, and the second so-called 'fresh' season stretches from April to September. In terms of hydrology, the district is drained by the Incomati basin system (see Figure 1.2 below).

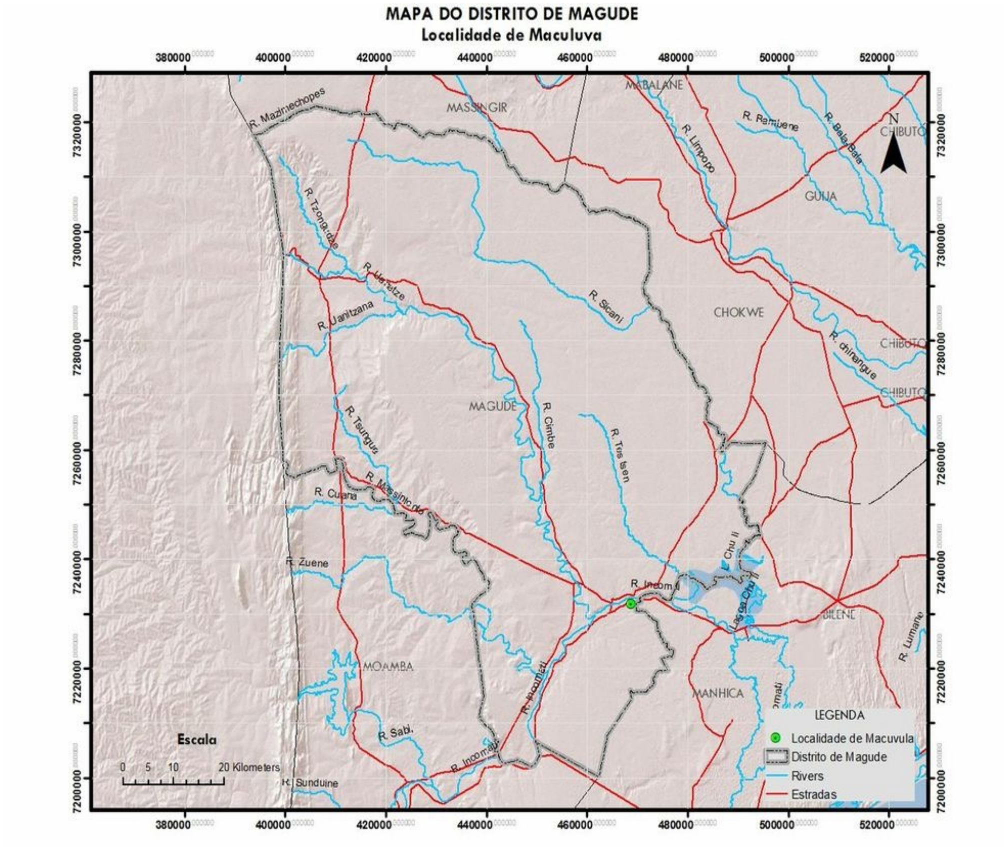

Figure 1.2: Map of the Magude district (Source: Author)

In terms of geomorphological structure the district is basically flat with heights of less than 100 metres or between 100 and 200 metres. The district's soil is mainly composed of red clay soil. This soil type is altered with franc-clay-sand soil offering a medium to good soil type. There are also rich fluvial soils on the banks of the river in the district. Despite this, farming on the fluvial soils is difficult due to excess water and salinity. In the district, there are also sandy soils with low water retention capacity.

The population in this area mainly practises subsistence farming (crop and livestock). They grow maize, beans, cassava, and peanuts that are mostly rain-fed with limited irrigation. Smallholder agriculture is expanding rapidly, and one private company is producing sugar cane. The Magude district is one of the biggest cattle producers in the Maputo province. In addition, the local community makes bricks.

Incomati River Basin: Hydrology and irrigation

The Incomati River Basin is fed by three major tributaries: the Sabie, Crocodile, and Incomati, with most of their basin areas located in South Africa (see Figure 1.3 below). A small part of the Incomati Basin is located in Swaziland. The Incomati and Crocodile Rivers join at the Mozambican border where the river's name changes to Incomati. The total area of the Incomati Basin in Mozambique is 15.388 km^2, covering 33% of the overall basin.

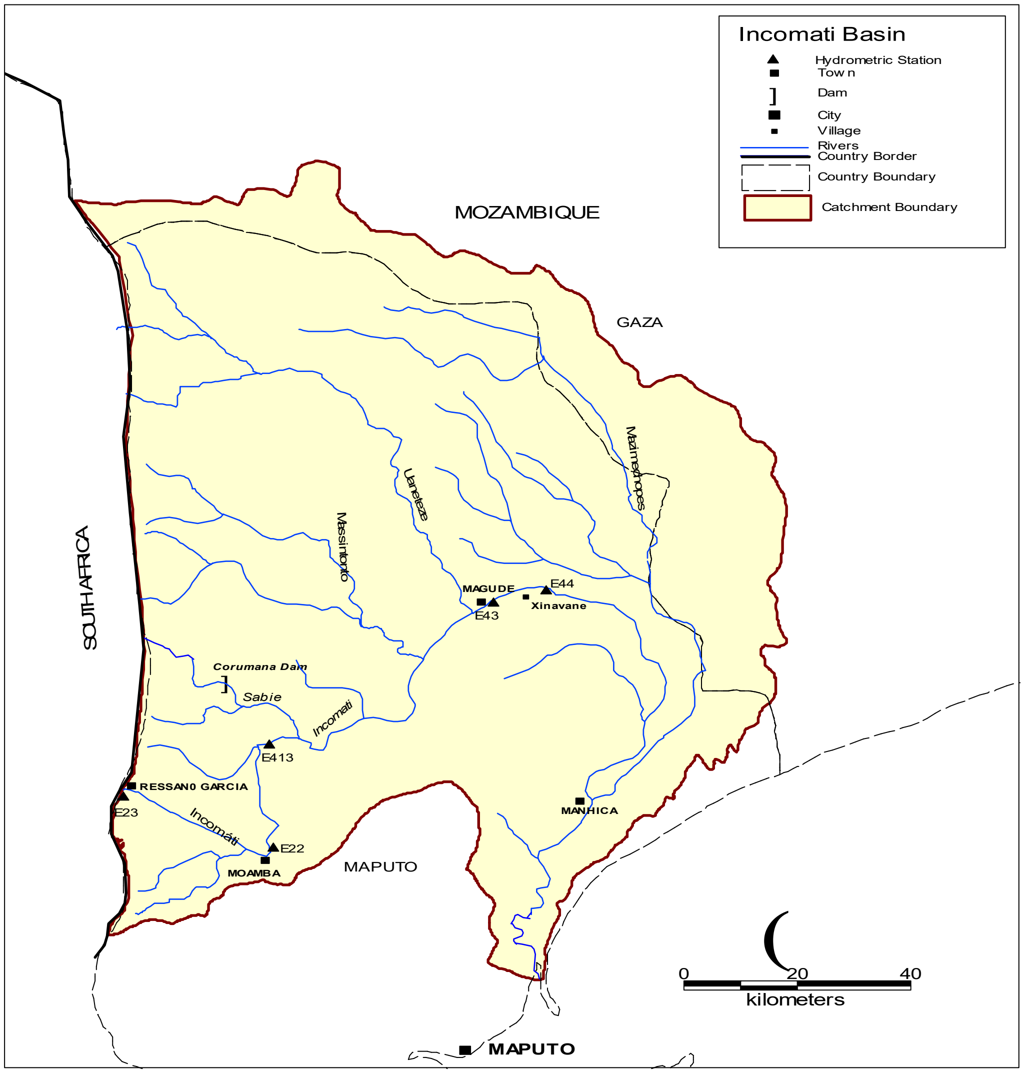

Figure 1.3: Incomati River Basin (Source: Management Unit of Incomati River Basin [MUIB])

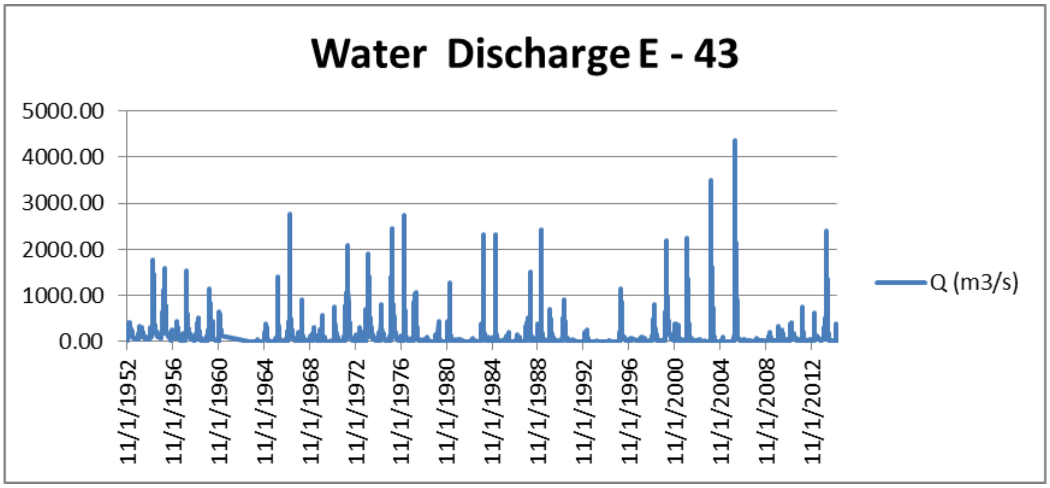

Figure 1.4: Water discharges at Magude station (Source: Author, data from NDW, section E43)

Figure 1.4 shows a hydrography of observed inflow from 1952 to early 2015 in section E43 of the Incomati River Basin. The figure shows the periods of higher inflow and a range of periods with very low inflow. This may reflect in water development and suggests the need for water storage for irrigation activities; otherwise there will be periods that farmers will be unable to produce outside of times when rain-fed practices are used, resulting in food insecurity.

The infrastructure irrigation area in the Incomati Basin is about 30.831 hectares, of which 12.465 hectares are in operation. The irrigated area is to be increased once the total infrastructure area is recovered (SWECO, 2003).

Actualised data from Incomati Water Authority indicates that in 2014 the estimated irrigated area was around 234.18 hectares and it is expected to increase in future to 637.44 hectares. The estimated water volume for irrigation was 22.81 million m^3 in 2014, with 62.84 million m^3 estimated for the future (ibid.). The largest irrigation water users are the sugar cane companies Xinavane and Maragra and they are expecting to increase their fields under irrigation for further sugar cane production (NDW, 2014).

1.6.2 The Massaca research site in the Umbeluzi Basin

Climate, topography and soils

The Massaca irrigation association is in the Boane district in the Umbeluzi Basin, which is also in the Maputo province of Mozambique as shown in Figure 1.5 below.

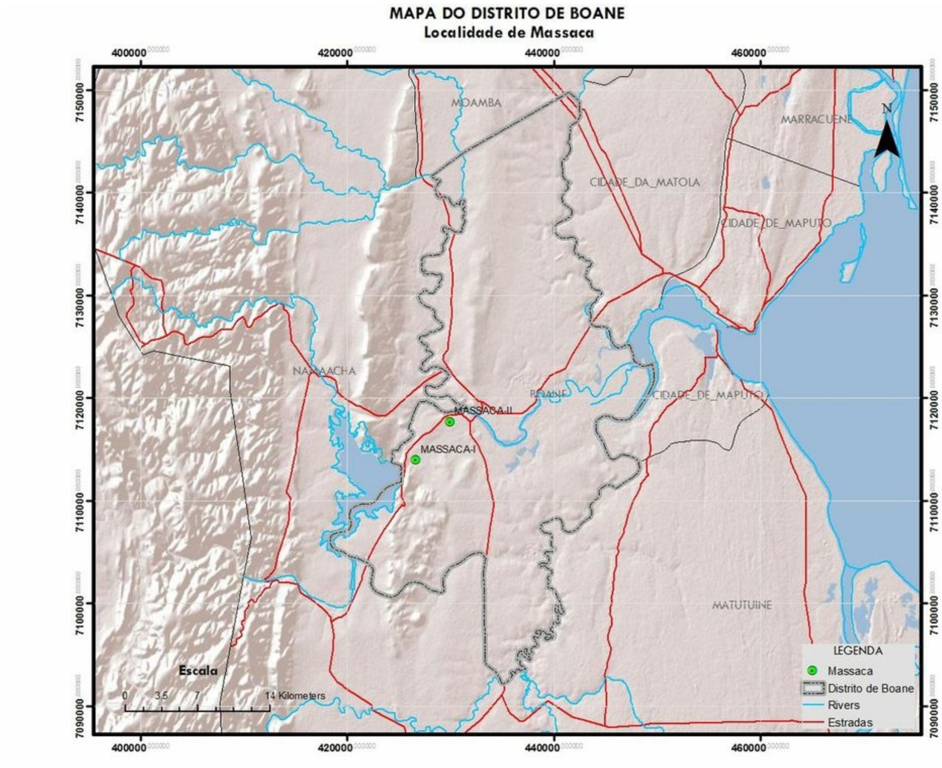

Figure 1.5: Boane district (Source: Author)

The Massaca irrigation association was established in the Boane district, located in the south-eastern region of Maputo province. In terms of hydrology, the Boane district is part of the Umbeluzi River Basin, Tembe, Matola, Movene, and Nwlte Rivers, which are periodical and effluents of the Umbeluzi. The most important of those rivers is the Umbeluzi, which flows into the Espirito Santo estuary, and includes the Matola and Tembe catchment. The Umbeluzi Basin is the water source for most large irrigation projects and supplies water to the cities of Maputo and Matola in the Maputo Province. The Pequenos Libombos dam was built in the Umbeluzi Basin as the largest water storage facility in the country and was also designed for hydro-power production. The Umbeluzi Valley has good soils with agrarian and livestock potential. The southern part of the district is appropriate for irrigation development, with available water bodies.

In 1997, the population of the Boane district was around 56.703; by 2005 this had increased to 81.406. The population is young and the population density is around 101 habitants per km^2. The main activity is agriculture, which forms the economic basis of the district. There is a significant expansion of smallholder agriculture as well as private companies, mostly citrus. There is also significant farming with livestock, mainly cattle and goats.

The Umbeluzi River Basin: Hydrology and irrigation

The Umbeluzi Basin is a shared basin between Swaziland and Mozambique. The Mozambican site is divided into sub-catchments and the research site is located at sub-catchment U12, as shown in Figure 1.6 below.

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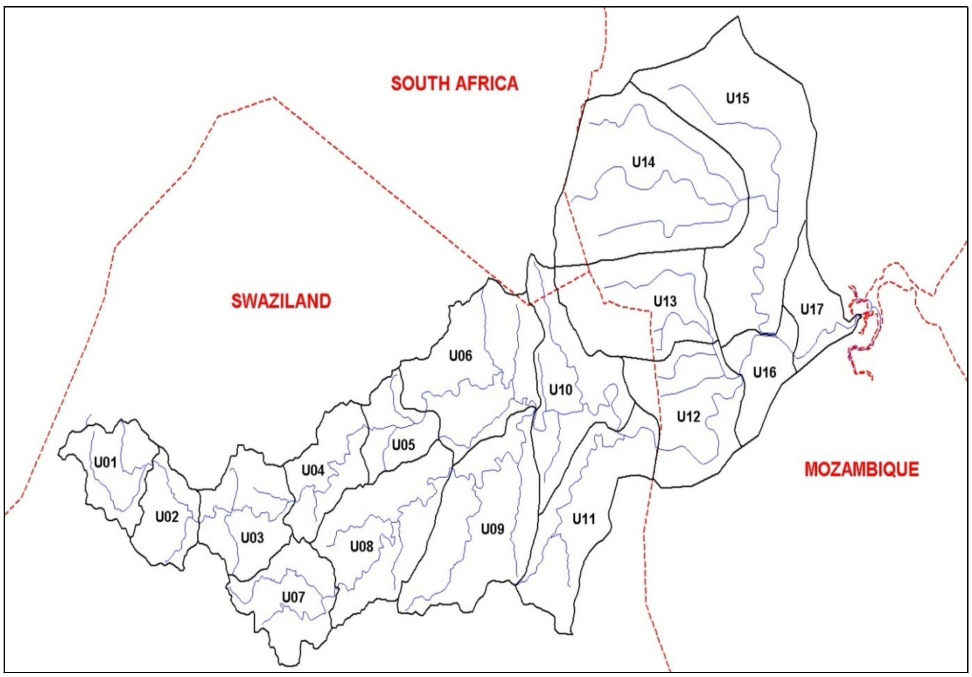

Figure 1.6: Umbeluzi Basin sub-catchment U12, Pequenos Limbobos, where the irrigation system is installed (Source: SWECO, 2003)

Regarding the Umbeluzi Basin, SWECO (2003) predicted an increase of 40% of equipped irrigation area by 2025, i.e. 3.445 hectares and it is expected by the government that the development of Movene dam may stimulate irrigation development in the Umbeluzi Basin. The water demand for irrigation in the Umbeluzi Basin is likely to increase in future (ibid.).

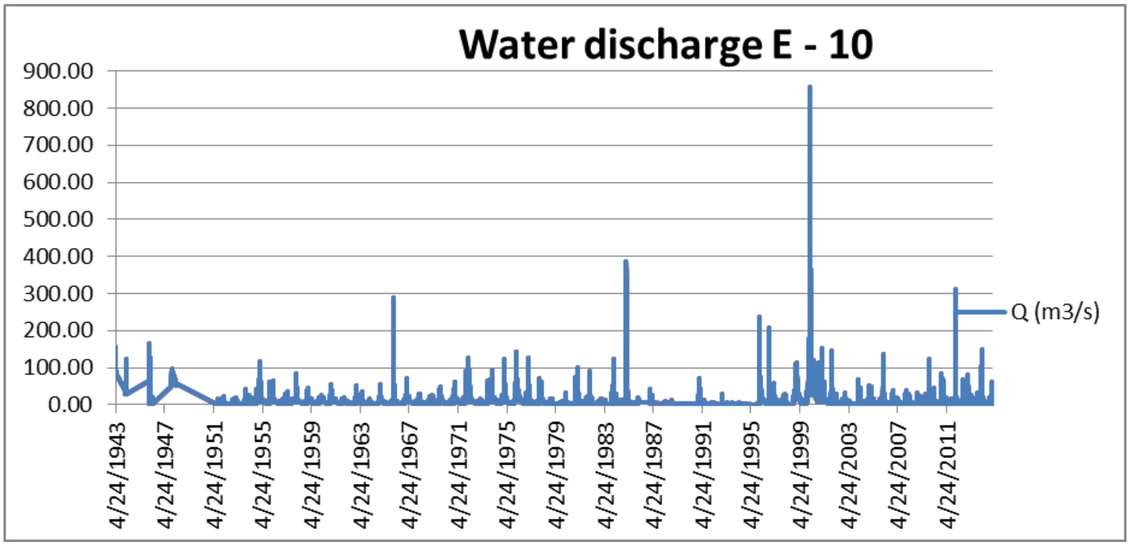

Figure 1.7: Water discharges at Goba Station 1943-2015 (Source: Author, data from NDW)

Figure 1.7 above shows the observed water discharged at Goba station between 1943 to early 2015 showing long stretches of low inflow sustaining irrigation development for farming.

The demand in 2025 is estimated to be 38.9 mm^3 (SWECO, 2003). This increase has to do with the increase of farming activities in the basin. The total area of the Umbeluzi Basin is 5 400 km^2 and the percentage of annual runoff is 22% of the average national annual runoff of 535 mm^3/year) (ibid.). In terms of hydrogeology, the Umbeluzi Basin consists of crystalline rocks, basalts and sediment rocks

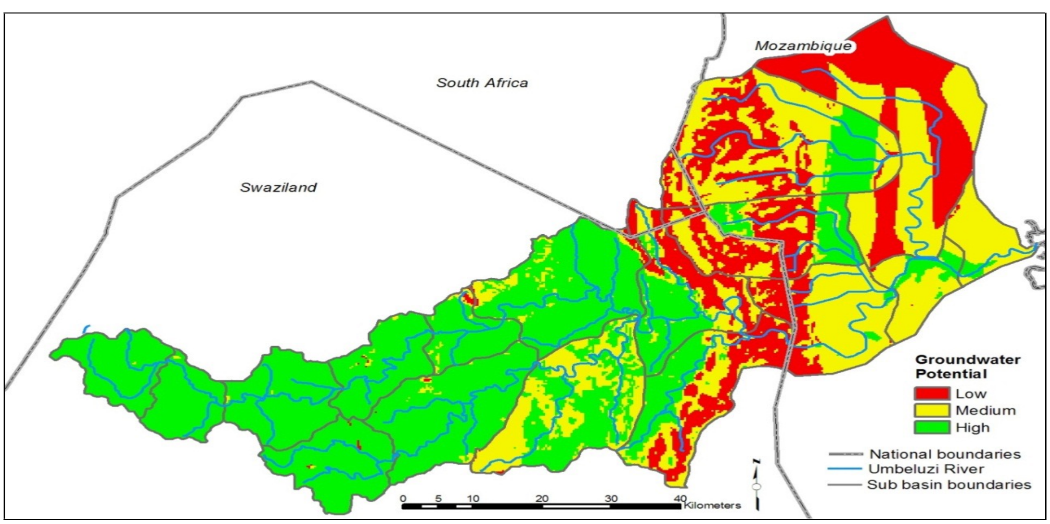

Figure 1.8: Hydrogeology of the Umbeluzi Basin (Source: SWECO, 2003)

with low porosity. The water is obtained in fault zones with low porosity which means that it is not feasible for high yields of groundwater and thus not appropriate to supply big demands of water, like for irrigation development. This is particularly the case for sub-catchment U2, which means that irrigation developments in this area rely on available surface water.

Further detail related to the community based irrigation scheme farmers and their related activity systems is presented in sections 4.2.3 and 5.2 of this thesis. I now briefly introduce some of the key concepts that were worked with in this study.

1.7 Concepts

1.7.1 Irrigation system

According to Wijayaratna (2002), an irrigation system can be described as a set of interactive subsystems, including both physical and functional systems. Its linkage (physical and functional subsystems) is hierarchical and continuous until water is delivered and applied at the farm level. Irrigation systems focus on getting the right amounts of water at the right time to fields, so that they make the most productive use of the available resources, i.e. labour, land, and capital (Uphoff, 2002).

Uphoff (2002) identified three groups of irrigation management activities, namely (a) water use activities; (b) physical structures that control water activities; and (c) organisation activities, both system-level and farm-level, that control these structures, which control the water. These activities often include (i) forecasting of the irrigation supply available and estimating irrigation demand; (ii) matching the supply to demand; (iii) scheduling and allocation of water resources and distribution in an equitable, efficient, and reliable manner (Uphoff, 2002). All the above managerial activities are aimed at the sustainability of the irrigation system.

Regarding water use activities, the tasks associated with irrigation may include: (i) acquisition of water either from surface or sub-surface sources, through creating operational structures like dams, weirs or wells; (ii) allocation of water by assigned rights, thereby determining who shall have access to water; (iii) distribution of water from the source to the users, in certain amounts at certain times; and (iv) drainage of water, where this is necessary to remove excess supply.

Activities associated with these tasks may include design and construction of technical structures to channel and store water which in turn requires operational activities, and maintenance activities. Importantly there are also decision-making activities that influence water acquisition, allocation, supply, drainage, design, construction, operation, and maintenance of the physical structure. Other activities may include resource mobilisation and management, including the mobilisation and application of funds, manpower, materials, information or any input needed, and ongoing coordination activities that involve conveying information about decisions, managing and engaging in conflict resolution that may arise from differences in interest that relate to the activities of acquisition, distribution, drainage, construction, maintenance and organisational activities. From this it is possible to see that irrigation system development is a complex social-ecological-technical concern that involves social, technical and ecological-agricultural competences and knowledge, and a range of interacting activities and a diversity of interests and practices.

1.7.2 Social learning

According to Wals (2007), there are various ways of describing social learning but it is essentially a process of social engagement in which people learn both individually and collectively in response to issues that concern the group involved in the learning process.

Wals, van der Hoeven and Blanken (2009) argued that social learning is referred to as the manner in which people actively commit to a far-reaching process of change via a willingness to learn from each other. Herein lies the interest of this research, because while learning can happen, transformation in action and practice may not occur, leaving learning mainly at the level of individual cognitive change. While some authors see transformative learning as transformation at the level of individual cognition (Klein & Baxter, 2006), in this research I am interested in transformative social learning at the level of changed action or practice in collective activity systems (Engeström, 2001). A change in action or practice shows collective engagement and can be seen as evidence of forms of social learning (ibid.). Engeström argued that transformative learning within a collective can be seen in a change or transformation of the collective activity (see section 5.6.3) and Engeström and Sannino (2010) argued that such transformation is visible via expanded collective agency. In the case of this study, the changed / transformed activity that I will focus on is development of communal irrigation scheme activity.

Wals et al. (2009) claimed that collective social learning takes place in a social context and brings people of different backgrounds together; the knowledge and experience that is brought about in this way is necessary for creatively answering questions for which there are no ready-made solutions. Further, Wals et al. (2009) suggested that social learning systems can be seen within a wider social interactive ecosystem. As such, social learning interactions are based in networks and involve mutual dependency, flexibility, and willingness to engage, even with dissonances and tensions. Such learning ecosystems are organised and can deal with disruption, meaning that it is not about individual principles and elements, but rather about the collective social or social-ecological system (Capra, 1994, 2005; Wals, 2009). Therefore, social learning emerges within a learning system in which people learn from and with one another and collectively become more capable of withstanding setbacks and dealing with insecurity, complexity and risk (Wals, 2009).

Within irrigation systems and related farmers' associations, the likelihood is that collective social learning has taken place in order for the communal irrigation scheme activity to begin; further, such learning is likely to be needed to manage, maintain and sustain the activity over time. Thus, transformative social learning is likely to be found in this activity in the process of its management, in use of the irrigation system for crop development, and in dealing with ongoing maintenance challenges. In order to cope with the complexity of irrigation tasks and to deal with uncertainties, it is also likely that ongoing transformative social learning is taking place, or may be required. As indicated above, this is the core interest of this study, i.e. to find out if and how such learning is taking place and/or may be further developed.

Wals (2007) made an important point when he noted that learning requires not only acceptance of one another's differences, but also the ability to put these into use; by this he meant that the new knowledge generated and shared could also potentially be praxiological, which aligns with the changed activity focus in Engeström's work referred to above. Hurst (1995) argued that social learning may also be characterised by a period of stability and calm once a system is able to cope with disruption as result of its learning process (Hurst, 1995). Transformative social learning is a process in which people are not only engaged in developing new activity together, but in which they are also "... stimulated to reflect upon implicit assumptions and frames of reference, in order to create room for new perspectives and actions" (Wals et al., 2009, p. 11).

1.7.3 Participation and irrigation

An important point in respect to participation for sustainability was presented by Wals (2009) when he noted that after more than twenty years of talk about sustainability and sustainable development, it had become clear that there is no single outlook on what sustainability or sustainable development means. It is clear that there is no one single process that will adequately realise its achievement. One approach to improving water allocation and effective water use within agriculture systems that are striving to be sustainable, as in the case of Mozambique, is Participatory Irrigation Management (PIM).

PIM refers to the involvement of water users in all phases of the irrigation management process, such as planning, operating, maintenance, monitoring, and evaluating of the irrigation system (Kummerdpet, 2010). The main issues in irrigation include inequitable water allocation, water distribution, poor irrigation maintenance, inadequate water availability, and lack of incentives for saving water. All these are said to be potentially addressed through a PIM approach (ibid.). However, there is increased evidence that applying the PIM approach by decentralisation and transfer of authority to local water user organisations (WUOs), does not guarantee success. Carefully designed institutional capacity building is needed, with due attention to the quality and outcomes of this process (United Nations Development Programme [UNDP], 2006).

Considering the above issues, this research explores participation and learning in the development of irrigation systems as a form of collective transformation towards sustainability. According to the International Association for Public Participation (IAPP) (2007), public participation is viewed “as any process that involves problem-solving or decision-making and that uses public inputs to make decisions on the matter” (unpaged). According to IAPP (ibid.), the requirements for participation include (i) easy access to information; (ii) equal opportunities to participate; (iii) chance to have a say in decisions that affect people’s lives; (iv) recognition of needs and interest of all participants; and (v) communication on how public input affects the decision (i.e. transparency). These points are relevant for community participation in the context of irrigation management. Kummerdpet (2010) indicated that resources, associated environmental management, and sustainability practices are currently characterised by changes, uncertainty, complexity, and conflict, and that greater public participation in resource and environmental management is necessary to increase the sustainability of resources (Ludwig, 2001; Diduck, 2004). Public involvement is important as participation, in the context of environmental decision-making, generally helps:

- to provide discussions between stakeholders, which allows them to identify problems more effectively (Kapoor, 2001);
- to ensure that the needs of the public are identified (Shepard & Bowler 1997; Innes & Booher, 2004);
- people to gain more understanding and information beyond the scientific approach (Usher, 2000; Kapoor, 2001;) and to access scientific and technological knowledge necessary for local practices;
- to maintain popular legitimacy (Kapoor, 2001); and
- to minimise conflict at the implementation stages and potentially in other phases in the process (Diduck, 1999; Mitchell, 2002).

The literature cited above also explicitly states that incorporating public participation in resource and environmental management could enhance sustainability of proposed projects or policy. In the context of this study, it could be argued that the above-mentioned assumptions for public participation are valid for community participation in the establishment of irrigation scheme practices, and that they may be relevant to the transformative social learning interest of the study. Of additional relevance to this study are the findings of Tessanee (2007), who identified two relevant principles for sustainable irrigation scheme management in his study on PIM, namely equality and transparency. Equality involves distributing benefits and costs of irrigation management in ways that will allow the farmers to become more confident in, and open to increasing their formal participation in the development initiatives. He also advocated that the foundation of equality of benefits depends on geographical and social conditions, the technology in use, and the project scale, which includes the farm intake size, water volume, farm acreage, and household size. The form of costs can be various and may include fees associated with local taxes, labour, equipment, and construction materials. Tessanee (2007) argued that all these should be the subject of agreements, which are reached through joint decision making in PIM. He further pointed out that the principle of equality is attached to the principle of transparency, in order to ensure that the principle of equality is really being applied. He further claimed that transparency of information on water demand supply and organisational management will maintain participation and make the irrigation management sustainable. These principles are also potentially important vantage points for considering aspects of the transformative social learning process.

Of significance to this study, are the findings of several recent research projects, which identify that irrigation schemes tend to fail due to a lack of attention given to participation in the start-up phases of establishing the irrigation schemes in developing countries (Ros, 2010). Consequently, participation is increasingly emphasised as being important in the establishment of these schemes, as is indicated in the Mozambique policy and in the concept of PIM (World Bank, 1996). This factor and the potential for an absence of participation formed the second goal of the study, namely to explore expansive learning opportunities as potential transformative social learning praxis (see Goal 3 and Chapter Six). Participation is also considered important in fostering social learning and transformation (Wals, 2007; Muro & Jeffrey, 2008) as noted above.

1.7.4 Irrigation and sustainability

The World Commission on Environment and Development in 1987 (WCED, 1987) defined *sustainable development* as development that meets the needs of present generations without compromising the ability of future generations to meet their own needs. This has been the foundational definition of sustainability, and the concept of sustainability has tended to focus on the interrelations between environment, economy and society (ibid.). If expanded to or conceptualised within irrigation systems the concept of sustainability may include the following, as shown in Table 1.4 below.

Table 1.4: Sustainability as interpreted in the context of irrigation system development

Dimension	Description
Technical sustainability	Appropriate structures, water efficiency, irrigation operation and maintenance, relevant technical equipment
Institutional (also political) sustainability	Human resources to run the irrigation system; political systems and policies that are enabling of participation in collective irrigation scheme development
Ecological sustainability	No damage to the environment, dealing with salinisation, climate variability, siltation, water-logging, water-related diseases, weed growth, water quality, water flow alteration
Economic sustainability	Poverty alleviation, employment, shared value and benefits
Financial sustainability	Cost recovery, funding mechanisms, incentives, viability
Social sustainability	Equity, participation, opportunities, competition for resources, conflict management, interests, cooperation

(Source: Author's own analysis)

Abernethy (1994) suggested a set of attributes that should be considered as the object for sustaining irrigation systems that include: (i) irrigation facilities; (ii) production potential; (iii) operational performance; and (iv) value of irrigated agriculture. He, typical of many who interpret sustainability outside of the environment-society-economy-political nexus, did not include the full focus on sustainable irrigation systems as outlined in Table 1.5 above. However, he suggested that insufficient utilisation of available facilities is occurring in several countries, and noted that sustaining output performance could be unsustainable if demand for the crop production weakens. His concept of sustainability is mainly economic-technical.

Wals (2009) claimed that global communities and companies, both big and small, around the world, are becoming aware that our current way of living is primarily oriented towards the short-term, and for others, especially the poor and future generations, short-termism, especially if only focussed on the economic-technical dimensions of sustainability, is unsustainable. Wals (ibid.) also noted that after decades of talk about sustainability and sustainable development, it appears easier to identify what is unsustainable (i.e. ecologically, socially, economically, ethically, culturally and environmentally) than to identify what it is to be sustainable. By stating this, Wals (2009) challenged researchers to not only discuss sustainability in terms of what is unsustainable or problematic, but to rather focus on how to create and generate sustainability in terms of practices or activity, which is a key focus of this study.

Wals (2009), and other researchers from the south, such as Mukute (2010) and Lotz-Sisitka (2016), have argued that by now it is clear that to break the deeply entrenched, unsustainable patterns (i.e. assumptions, behaviours and values) that were established under coloniality and modernity, will require a new kind of thinking, inspired and informed by powerful learning processes that simultaneously lead to individual and collaborative action and transformation. Lotz-Sisitka (2016) and decolonisation theorists such as De Sousa Santos (2014) have argued that such processes require giving attention to both absence (what is not there and what is unsustainable) and emergence (what could be there, and what could be sustainable). This would seem to be the case for sustainable irrigation system development in post-war and post-colonial Mozambique. Bhaskar (2008) suggested that dialectical critical realism can provide a way of theorising such transformative social learning that emerges from being (i.e. the situation that is now) to becoming (the situation that is becoming transformative). He suggested that dialectical critical realism can underlabour for such a transformative process of being and becoming under conditions of poverty and climate change (Bhaskar, 2010). I explore this in the context of irrigation scheme development in Mozambique in the two case contexts.

1.7.5 Learning and sustainability

Social learning, and particularly transformative approaches to social learning, has gained currency in the field of Environmental and Sustainability Education[4] in southern Africa and elsewhere (Masara, 2010, Mukute, 2010; Belay, 2012; Lindley, 2013; Sabai; 2013). Tabara and Pahl-Wostl (2007) pointed out that social learning, particularly within a vision of wider societal change, has been associated with the concept of sustainability. Milbrath (1989) in his work envisioning a sustainable society used the phrase ‘Learning our way out’, signalling a transformative process of negation. In his view, social learning happens when a dominant institution is replaced by another (Tabara and Pahl-Wostl, 2007), or when an absence of a new institution has been absented i.e. when a more suitable or needed institution comes into being (e.g. the Ministry of Environment in Mozambique which did not exist 25 years ago). This means a change or transformation of societal practices and norms that are shared by many actors. Engeström, as noted above, suggested that societal transformation takes place via

[4] Environment and Sustainability Education (ESE) is used in this study to show the confluence of Environmental Education (EEASA, 2002) and Education for Sustainable Development (UNESCO, 2005) in the southern African region. The origins of this field lie in environmental education as outlined in the Tbilisi Declaration of 1977, and as developed regionally via the Environmental Education Association of Southern Africa (www.eeasa.org), and later further expanded via the UN Decade on Education for Sustainable Development by the UN, as led by UNESCO (2005-2014).

expansive learning processes that can change or transform human activities, e.g. rain-fed agriculture to community-based sustainable irrigation led agriculture.

Tabara and Pahl-Wostl (2007) pointed out that, according to Milbraith (1989), for social learning to embrace sustainability, people need to learn (i) to become aware of their ways of knowing; (ii) to understand the critical role of values and beliefs in structuring reality, and that science is not a free value; (iii) to reason with each other in public debates about their values to reorient scientific and societal development, which is reflective of Bhaskar's (1998) focus on dialectically transformed and emergent ethics-based agency; (iv) to appreciate the complexity and interconnectivity of ecosystems and their implications for social action; (v) to think systemically, holistically, and integratively; (vi) to not separate human societies from nature, but to live in harmony with nature instead of dominating it (i.e. to have a social-ecological systems view of the world); (vii) to avoid interfering with natural systems and cycles wherever possible and recognise the limits to *unfettered, unsustainable and greed-driven* growth; and (viii) to empathise with people of other lands, other species, and future generations to preserve the ecosphere, which is reflective of Bhaskar's (1998) concept of totality, which is core to his dialectical logic of being and becoming as an emancipatory, transformative process (see section 7.2). While these points are all valuable for wider sustainability, Milbraith did not develop his theory from the perspective of people in the South who are often thrown into poverty not of their own making. In this study, I will critically consider the view of Milbraith from the perspective of the Mozambican farmers in the irrigation systems and their experience.

Wals (2007) pointed out that a reflexive learning society will need the capabilities to reflect on existing norms and values, and to correct itself where necessary. A reflexive society requires reflexive citizens who can critically review and alter everyday systems that we live by and that we often take for granted (as is proposed by dialectical critical realism outlined above). Wals (2009) stated further that there is a need for a new kind of learning, arguing that we cannot think about sustainability in terms of problems that are out there to be solved or inconvenient truths that need to be addressed, but instead need to think in terms of challenges and realise that as soon as we appear to have met these challenges, the horizon will have shifted once again. Thus, learning and sustainability can be perceived as potentially transgressive, open-ended processes that takes place in open systems (Lotz-Sisitka, 2016; Bhaskar, 2010). Nunez (2014), drawing on the work of Bhaskar, suggested that such learning needs to be ontologically grounded and dialectically emergent i.e. learning as product (what is); learning as process (becoming); learning as process-in-product (emergent in relation to totality); learning as product-in-process (agency and transformative praxis) (see sections 7.2, 7.3, 7.6).

Sustainability oriented education processes associated with irrigation scheme development are aimed at leading to efficient water use through crop production using new technologies that increase crop production while also ensuring water conservation and social and economic value for the communities engaging in the practices. They therefore also deal with economic and financial aspects of the practices, and include issues to do with planning and organisation, including social cohesion, cooperation and societal values. These topics tend to form the focus of the learning, training, extension and capacity building activities.

Various authors have argued that ultimately such education processes are necessary to equip irrigation farmers with knowledge and tools for active participation and practising of sustainable irrigation systems (Kummerdpet, 2010; Ros, 2010; Tessanee, 2007). However, as mentioned above, such learning is not without complexity, as sustainable development is notoriously considered '*a wicked problem'* (Rittel & Webber, 1973) whose resolution ultimately depends on the capacity of different actors and groups to dialogue in practice, reach consensus and make collective decisions (Pahl-Wostl, 2002; Schusler, Decker, & Pfeffer, 2003; Woodhill, 2004; Wals, 2007). This is because sustainability in any context is difficult to define in advance, and requires participation of people to co-define and to situate it in contexts of practice, while at the same time taking account of its global context and features (ibid.).

Because of the complex and often contested nature of sustainable development and its proposed solutions, Environment and Sustainability Education above all means the creation of space for transformative social learning that includes taking account of diversity; and dealing with arising conflicts and tensions (Wals, 2007). Such space includes: space for alternative paths of development; space for new ways of thinking, valuing and doing; space for participation minimally distorted by power relations; space for pluralism, diversity and minority perspectives; space for deep consensus, but also for respectful disagreement (Limbach & Van Arcken, 2002) and differences (Olson & Eoyang, 2001), space for counter-hegemonic thinking, space for self-determination, and, finally, space for contextual differences. It is in this context that Wals (2007) explained the need for people to 'reflexively learn their way to sustainability', a process which requires transformative social learning.

While the literature describes these many different processes that are apparently embedded in social learning towards a sustainable future, little of it reflects on how these processes may or may not contribute to transformed practices; and how these transitions and transformations actually occur as people move from one type of practice (e.g. reliance on rain-fed agricultural practices) to new forms of practices (irrigation scheme agriculture) that are judged by policy and society to be more sustainable as they reduce poverty effects, while also addressing water conservation issues, and increase food security and other social benefits (e.g. new organisational formations). Thus, transformative social learning is under-theorised and under-researched from a 'transformed practices' perspective, an issue which this study seeks to explore in more depth.

To examine this problem, this research will probe (in some depth): the social learning processes associated with practices and irrigation system activity development involved in two cases of transition from dry-land rain-fed agricultural practices, to farming with irrigation to understand how social practices are producing knowledge that may foster sustainable irrigation; and / or how knowledge and learning may produce new sustainable irrigation system activity (or not).

As indicated above, the farmers' organisations will be the primary unit of analysis or activity systems under study (with related activity systems included); and possible transformative social learning will form the key focus of the study, as communities are supported to take up new practices and collective actions through participation in the activity of sustainable community-based irrigation schemes development (the activity or collective object under study).

1.8 Thesis structure and outline

As indicated above in the research design section, this study was conceptualised in three phases, and reporting on these phases is broadly organised into various chapters of the study (see Figure 1.1: Research design). However, before the data presentation and reflective analysis chapters, there are introductory, theoretical and methodological chapters, as shown in the outline of chapters below.

Chapter One: Introduction to the study – In this chapter I have presented my motivation for this research. I further presented the history of community-based irrigation management, the institutional set-up regarding irrigation and irrigation associations in Mozambique. The aims, goals and research questions were set out. To provide perspective on these, the chapter discussed current issues in the irrigation sector in Mozambique, and provided a description of the two research sites that form the focus of the case studies in this research. To facilitate further understanding of the interest of the study, key concepts that underlie this thesis were briefly discussed, after which this section on the structure of the thesis is presented.

Chapter Two: Theoretical framework – Chapter Two provides the theoretical framework in which this study is embedded. The chapter expands on the introductory conceptual framing of social learning presented here in Chapter One, and provides further insight into social learning theory (e.g. concepts, issues, paths, social learning in irrigations schemes). It will also review the concept of and past research on transformative learning and critical realism including history, Bhaskar's dialectical critical realist MELD schema and interest in transformative praxis).

Chapter Three: Methodologies and Cultural Historical Activity Theory research – In this chapter the methodologies that were used within the research context for the data gathering and analysis are presented. The study is constituted as a qualitative, action-oriented, expansive learning research process that focuses on transformative social learning at the interface of connected activity systems involved in communal irrigation system development, conducted as multiple case studies to explore social learning processes and transformation in irrigation system development. The methods applied in the study are shaped by cultural historical activity theory research which identifies and analyses dynamics of, and contradictions within and between human activity systems focussing on the same object (communal irrigation system activity in this study), and which then seeks to engage researchers in an expansive phase of learning and change in engagement with emergent contradictions. This research process is guided by first, second and third generation cultural historical activity theory (CHAT) which uses Development Work Research, and Change Laboratories as methodological processes of expansive learning. The methodology (theory of method i.e. CHAT) and methods (i.e. research techniques or approaches such as change laboratory workshops) are described in this chapter.

Chapter Four: Macubulane Leaning case study and identification of contradictions for potential expansive learning – This chapter is dedicated to the Macubulane irrigation association case study. It describes the first research site and assesses the activity systems and learning processes. It looks at the dynamics of activity systems, rules, mediation tools, community members, division of labour and subjects, and examines the learning of new irrigation scheme practices. The chapter identifies the contradictions within and between the activity systems as potential foci for further expansive and potentially transformative social learning. The chapter further examines learning practices and reflexivity within the irrigation association as reflexivity is a core process necessary for shifting from being to becoming according to Bhaskar's transformative model of social action (Bhaskar, 1998; 2010), which lies at the heart of his dialectic, in which he sees learning as a key process necessary for a passage through the dialectic.

Chapter Five: Massaca learning case study and identification of contradictions for potential expansive learning – This chapter is dedicated to the Massaca irrigation association case study. It describes and assesses the activity systems and learning process in a similar manner to those of the Macubulane irrigation association development. I consider the same features of the irrigation association activity systems, their contradictions and potentials for expansive social learning as in the previous chapter. Key differences with the previous chapter are contextual and consider how the association is structured, and the methods they use for irrigation, all of which are based on some similar, and some very different contradictions and tensions, and thus different potentials for transformative social learning.

Chapter Six: Expansive learning through change laboratory workshops – This chapter specifically reports on expansive learning processes as these unfolded in the two case studies. It begins with a description of the contexts of expansive learning, and provides insight into the strategies I used to foster expansive learning. I also provide a description of the actual process of expansive learning that occurred, which includes the process of collective identification of contradictions and analysis thereof, and emergent responses and solution modelling in response to these. These engagements provide a focus for an expanding collective zone of proximal development, through which I further discuss the potential for transformative social learning, as outlined via an analysis of existing and potential agency and collective zones of proximal development in the two community-based irrigation schemes under study.

Chapter Seven: Concluding the study on transformative social learning and sustainability in community-based irrigation scheme development in Mozambique – In this chapter I deepen the analysis by including a consideration of both nominal and real absences and possibilities for ongoing transformative social learning. The chapter begins with an examination of absences existing in the existent social learning processes and irrigation practice contexts. I further discuss the processes of absenting absences through ongoing dialectical transformation possibilities. I also examine the generative mechanisms of learning and transformation in irrigation systems and the agentive discourses. Finally, I explore the learning polysemy of real negation or learning in irrigation associations. This chapter examines the issues of learning for sustainability in irrigation associations, in terms of perception of sustainable development and the pedagogical methodologies of learning for sustainability. It then provides a conclusion of transformative social learning and finally, expands on the curriculum for learning in irrigation associations.

CHAPTER TWO

Theoretical Framework – Social Learning, Transformative Learning and Critical Realism

2.1 Introduction

While the theories that inform this present study have been applied to many different applied research contexts in this study, these theories are interpreted in relation to the context of natural resource management, with an emphasis on transformative social learning in the context of Participatory Irrigation Management (PIM).

Several synthesis works on social learning and Natural Resource Management (NRM), for example those of Pahl-Wostl and Hare (2004); Muro and Jeffrey (2008); Rodela (2011); Cundill, Cumming, Biggs, & Fabricius (2012) have shown that social learning is an important feature of adaptive co-management of natural resources and that it can occur at different levels in a system, namely, at the level of the individual (e.g. cognitive, attitude and behaviour changes); at the level of the community of practice (e.g. changed practices); and at the level of the wider system (e.g. changes in governance and management systems and approaches). These authors argued that it is at the latter two levels that transformation of natural resource management practices can be observed as a potential outcome of social learning (Cundill et al., 2012). However, the authors do not provide in-depth insights into *how* these transformations come about through transformative social learning processes; this is a gap which this study hopes to fill.

This present research draws on Cultural Historical Activity Theory (CHAT) and expansive learning to further examine the complex process of learning within irrigation systems and to approach the change from dry land rain-fed irrigation farming to irrigation farming as a process of expansive (and potentially transformative) social learning. To look into the learning process, I draw on perspectives on social learning, the concept of participation (outlined in Chapter One), as well as perspectives on communication and transformation. Together, participation in social learning, communication and transformative processes provide the conceptual lenses to examine the expansive learning and change processes (as a potential transformative social learning) as these may or may not reflect transformed practices in the change from dry land agriculture to sustainable irrigation scheme use, with the emerging structures, agency and associated relational interactions that sustain these. Studies by Mukute (2010), Masara (2010), and Belay (2012) have shown that such transformative social learning processes can emerge in community based natural resource and agricultural management contexts in rural African contexts. While their work shows these possibilities and proposes various models and approaches to understand the role of participation and social learning in such changes, they have not explored *transformative* social learning in the context of Natural Resources Management (NRM) practices. This is another gap this study hopes to fill. This chapter discusses the social, communicative and transformative learning dimensions of the theoretical framework of this study, in the context of community based natural resource management.

2.2 Social learning

This section discusses the concept of social learning from various perspectives and in the context of water management.

2.2.1 Social learning concepts

Even though social learning research is rapidly on the increase in natural resource management contexts (Rodela, 2011; Cundill et al., 2012), there are many outstanding questions related to what social learning means, what is meant by transformative learning, and what the linkage is between transformative learning and social learning, i.e. what is meant by 'transformative social learning'. This section aims to refine this understanding.

Social learning has become a great concern in the context of adaptive natural resource management for its sustainability and participatory potential. The review of social learning concepts and theory outlined in Table 2.1 is drawn from the work of Muro and Jeffrey (2008). They identified the evolution of the concept of social learning in participatory processes through a literature review of work produced by various scholars.

Table 2.1: Concepts of social learning (adapted from Muro & Jeffrey, 2008)

Reference	Definition of social learning	Components / dimensions of social learning evaluated
Webler, Kastenholz & Renn (1995)	Social learning as a process in which changes in popular awareness occur, and changes in how individuals see their private interest linked with the shared interest of their fellow citizens	• Cognitive enhancement: acquisition of knowledge as well as learning about collective values and preferences and subjective impressions and findings of others • Moral development: interest in the common good • Features/methods of participation process
Daniels & Walker (1996)	Social learning as a process of framing issues, analysing alternatives, and constituencies to reflect on their own and others' values, orientations, and priorities in the context of deliberation	• Understanding of the management situation • Relationship • Preferences concerning processes for achieving projects goals • Features/methods of participation process
Saarikoski (2000)	Collaborative learning as a process where parties learn about the policy goals, alternative strategies and their consequences, and learn to better understand their own beliefs, values, hopes and fears, and those of others	• Understanding of the management situation • Learning about one's own and others values, beliefs and preferences
Schusler et al. (2003)	Learning that occurs when people engage with one another, having diverse perspective and experience to develop a common framework for understanding as basis for joint venture	• Acquisition of factual knowledge • Understanding of other participants • Discovering areas of agreement, disagreements, problems, and opportunities • Learning about community capacity • Features/methods of participation process
Rist, Escobar, Weissman & Zimmerman (2007)	Social learning as a process of communication, deliberation and collective learning, establishing and changing relationships, thus contributing to transforming existing forms of governance	• Trust and self-confidence • Patterns of communication • Mutual perceptions and interrelation between local and external knowledge

As can be seen in Table 2.1, there is a clear expansion in more recent literature of social learning theory from the early stages, which were relatively behaviourist. The shift is towards a broader perspective at the level of the planning process, involving decision making, deliberation and leading to sustainable resource use, management practices and governance activities (although the changed practices are not explicitly included in the analysis above). Table 2.1 shows this evolution of the social learning concept in the context of natural resource management. A similar evolution of the concept is also reported in Cundill et al.'s (2012) review of social learning in NRM. The more recently developed understandings of the social learning concept are relevant to this particular study, which considers social learning as a process of communication, deliberation and collective learning, establishing and changing relationships, and thus contributing to transforming existing forms of governance for sustainability. In addition, I focus on changes in practice. Mukute's (2010) study focused on expansive social learning of sustainable agriculture practices and its findings showed that changes in practice are possible. His study does not, however, adequately theorise the *transformative* aspect of the social learning processes; this is my particular interest and is discussed further in this chapter.

One of the most interesting explorations of social learning comes from environmental learning visionaries, who argued that social learning includes: (i) a long term process with core community participants, the broader community of researchers, and facilitators; (ii) creating a process that allows an exchange between core participants; (iii) knowledge sharing and learning by all, including the facilitators and researchers; (iv) co-developing the learning process with participants; and (v) learning through reflexivity (Cundill et al., 2014).

Wals (2009) provided an extended perspective on the above-mentioned view of social learning in the context of environmental education when he proposed that social learning occurs best when divergent interests, norms, values and constructions of reality meet in an environment that is conductive to learning. In addition, Wals (2009) argued that social learning happens at multiple levels, i.e. the individual level, the group or organisational level or at the level of the network of actors and stakeholders. Another important perspective is given by Keen, Brown and Dyball (2005) who noted that social learning is "the collective action and reflection that occurs among different individuals and groups as they work to improve the management of human and environmental interrelations" (p. 4). This perspective, like the work of Mukute (2010), Belay (2012) and Lindley (2014), links social learning with agency, which refers to the ability to act in the world. Understanding agency requires a focus on reflexivity (Mukute, 2010; Belay, 2012; Lindley, 2014), involving, for example, a focus on farmers' understandings, their values and reflexivity (Cundill et al., 2014). Reflexivity can be described as process where people with common goals keep reflecting on their actions in order to effectively reach to their motives, goals or needs (Archer, 1995).

Muro and Jeffrey (2008) argued that discourse on social learning in participatory natural resources management has links to theories of communicative and transformative learning, adaptive management and soft system thinking, as outlined in Table 2.2 below.

Table 2.2: Theories and concepts associated with social learning in participatory natural resources management *(adapted from Muro & Jeffery, 2008)*

	Communicative learning	**Transformative learning**	**Associated concepts**
Theories	Situated learning	Experimental learning	Adaptive management
View of learning process	Learning is viewed as increasing participation in communities; individuals acquire knowledge through relationships. People think in conjunction or partnership with others	Critical reflection and perspective transformation in disorienting situations, learning through accommodation and assimilation of new knowledge	A guiding principle for the interface between society and biosphere. It stresses the need for flexible and diverse regulation, enabling change, and corrective action
Focus of learning	Co-participation; social learning relationship; internal construction of reality by individual	Internal construction and perspective of individual	Soft systems thinking stress the link between humans and their environment. It aims to gain insights into the whole by understanding the linkages and interactions between the elements that comprise the whole system
Purpose of learning	Construct knowledge, move from multiple to shared cognition	Create more inclusive views of the world and oneself, erase distortion in thinking	
Manifestation of learning	New knowledge, perspective transformation	Perspective transformation	Perspective transformative

The literature on natural resources management clarifies and refers to social learning as a collective process of decision making and governance (Muro & Jeffrey, 2008). Meinzen-Dick, Di Gregorio and McCarthy (2004) considered the main feature of social learning to be related to the concept of collective action, in which a group of people act together, share a common interest and take common action to address a shared interest, motive or need. In this context, social learning is viewed as a prerequisite for individual behavioural change leading to collective action. As can be seen from Table 2.2 above however, Muro and Jeffrey (2008), in considering transformative learning, focused more on individual cognitive aspects of transformative learning. This conceptualisation of transformative learning tends to neglect socio-cultural and historical aspects of social learning and its emergence in NRM contexts. Some research, drawing on Engeström's cultural historical activity theory, is emerging in this area in southern Africa (e.g. Mukute, 2010; Masara, 2011; Belay, 2012; Lindley, 2014), but, as mentioned above, this work is currently under-developed in terms of its understandings of *transformative* social learning, particularly in the context of communal irrigation management in Mozambique.

2.2.2 Social learning in the context of water resources management

Studies in water resources management have identified different factors that foster and constrain social learning. According to Tippett, Searle, Pahl-Wostl and Rees (2005), factors that can foster social learning in the context of multi-party water resources management initiatives include: (i) integration of stakeholders; (ii) managing of conflict between involved parties; and (iii) encouraging the development of mutually beneficial solutions.

Tippett et al. (2005) argued that these challenges require skilled planning and facilitation, thus there is a need to explore ways of maximising the potential for social learning. Achieving this requires consideration of communication and facilitation processes, and the same authors noted that effective participation can only take place in a suitable environment. Either poorly designed or inappropriately used communication tools, for example, with too much technical content, can act as a barrier to social learning (ibid.). This was also a finding by Masara (2010) in his southern African community-based social learning research.

A social learning approach requires both water managers and stakeholders to commit to creating the right environment for learning to take place. Socio-cultural theorists refer to this as 'sharing a common object'; this may require cognitive changes, organisational structure, and object commitment from learners. It also requires resources and mediation tools, in and careful consideration of process management which can help to support those changes. Cultural historical activity theory researchers (Engeström, 1987; Engeström & Sannino, 2010) proposed giving attention to division of labour, rules, mediating tools, subjects and how these relate to the shared object of learning (see section 3.4.1.3 and Chapters Four, Five and Six).

In a natural resources management context, it is argued that the organisers of social learning processes or events need to show commitment, enthusiasm in driving social learning according to early findings from HarmoniCOP European Case Studies in Public Participation in River Basin Management (Tippett et al., 2005). For instance, stakeholders in the Ribble Catchment considered the high commitment from senior agency managers as a motivating factor for their own involvement (Makin, Senders & Semithers, 2004). This requires development of critical capacity, the ability to reflect on underlying assumptions and capacity to act on the interactions between these assumptions and behaviour (both organisational and individual) (ibid.). This critical capacity may need to be encouraged through facilitation and process design that considers trust, transparency, respect, and openness as explained by Muro and Jeffrey (2008). Sociocultural theorists suggest that facilitation or supportive engagement within a social learning process involves 'boundary crossing' capacity (Wals, 2009) (see

Chapter Six). Cultural historical activity theory researchers suggest that there is an important formative intervention role for researchers in mediating and supporting social learning (Engeström, 2011; see section 6.1), but that the social learning process must be owned by those involved in the activity systems i.e. those who share an interest in a common object (in the case of this study this would be those who are interested in communal irrigation scheme activity).

Tippett et al. (2005) have identified potential barriers to social learning in water resources management. One of these barriers is insufficient provision of time and resources. They explained that deadlines are often tight, and the ambitious goals and timescales of the water development projects may push water managers to rush participatory processes, such that participants feel that they are not being involved in a meaningful way in decision-making. They also argued that a failure to ensure adequate representation of stakeholders, or being unable to attract a sufficiently broad range of stakeholders and key players, can lead to decisions seen as lacking legitimacy. Technical, financial and resource constraints can also have a negative impact on the ability of stakeholders to remain involved in the process (ibid.).

Tippett et al. (2005) also pointed out that resource asymmetries between stakeholders need to be identified to ensure more equitable platforms for involvement. They further argued that it can be difficult to maintain a long-term interest, which is required to develop social learning and long-term plans. The lack of trust and appreciation of the ways in which stakeholders can contribute to the success of river basin management can impede social learning. Such issues as those reported above in the literature, inform the analysis of the present study and help to identify factors that either foster or constrain social learning within irrigation systems. Understanding these issues also helps with the identification of contradictions and tensions, which may manifest themselves in barriers in the irrigation scheme development processes. These factors, according to socio-cultural theorists, who, as noted above, use a slightly different discourse to water management practitioners in describing social learning processes, may be potential sources for learning and change (Engeström, 2011). The next section discusses the concept of communicative learning and its relationship to social learning, which emerges through participation.

2.3 Communicative learning

Van der Veen (2000) argued that learning becomes more complex and dynamic as it shifts from a reproductive to a communicative or dialogical style as is also reflected in Table 2.1 above. Early social learning theory focussed more on behaviour modelling following the work, with later social learning focussing more on dialogical, interactive approaches that are facilitated as mentioned above. Social learning theorists, as well as cultural historical activity theory researchers, all draw on the work of Gregory Bateson (1973) which informed the work of Argyris and Schön (1978) who made a widely cited and important distinction between reproductive learning as single-loop learning, communicative learning as double-loop learning, and reflexive learning as triple-loop learning (Johnson & Johnson, 2000).

Habermas (1981), a sociologist who developed a theory of communicative action, talked about four types of learning: i) instrumental in which learning aims to control the environment or other people to enhance efficacy in improving performance; ii) impressionist in which learning is to enhance one's impression on others, or even to present oneself; iii) normative in which learning is oriented to common values and a normative sense of entitlement (members of a group are entitled to expect certain behaviour); and iv) communicative learning to understand the meaning of what is being communicated. Mezirow (1997) pointed out that communicative learning aims to understand a meaning of an interpretation of something. Communicative learning involves understandings, values, beliefs and feelings, and for transformative learning to occur as framed by Mezirow (1997), it is important that learners become critically reflective of the assumptions underlying those intentions, values, beliefs and feelings.

Van der Veen (2000) provided more orientation on learning types, further differentiating instrumentalist or reproductive learning from communicative learning and reflexive or transformative learning. His differentiation suggests (i) reproductive learning which implies simple acquisition of knowledge; (ii) communicative learning which involves dialogical communication with others, in order to reach consensus on building of the world; and (iii) reflexive or transformative learning which implies development in individuals of more inclusive, less distorted perspectives of the world and oneself (Mezirow et al., 1990).

Focussing on communicative learning, according to Van der Veen (2000), becomes important in situations where there is no clear knowledge available about the world or the best solution for a problem is unknown" (p. 17), as may be the case in establishing sustainable irrigation schemes in the community contexts outlined above. Comprehensive communicative learning implicates building amongst participants an inter-subjective understanding of the subject under discussion (ibid.). Van der Veen (2000) stated further that in the literature, communicative learning is also called *social constructivism* and that constructivism is an umbrella term for various types of theory, ranging from experiential learning (Lewin, 1935; Dewey, 1938) to the social-cultural school in Russian learning psychology (Vygotsky, 1978; Engeström, 2000), to situated social learning (Wenger, 1998).

Moreover, Van der Veen (2000) claimed that the idea of communicative learning assumes that groups can learn through communication and reflection, that groups are often in many respects more intelligent than individuals, and that groups can often strongly motivate individuals to learn. However, this does not always happen and much depends on the facilitator of the process. Johnson and Johnson (2000) gave some examples of how cognitive learning in groups is superior to or adds value to individual learning. For example, a group discussion dealing with a specific problem can result in ideas and insights that the individual members had not previously thought of. An open discussion can lead to a more complete picture of a particular decision than most members would have been able to formulate by themselves. Similarly, group discussions may be better at recognising and rejecting unsuitable solutions than individuals working alone, although this is not guaranteed. Johnson and Johnson (2000) further argued that groups have a more accurate memory of facts and events than individuals.

This interest in collective forms of communicative learning is a key feature of Engeström's (1987; 1999b; 2001) Cultural Historical Activity Theory (CHAT) (see Chapter Three), which is a sociocultural theory of social learning and change. Engeström termed this ***expansive learning***, a theory which he developed in workplace contexts out of the earlier Vygotskian sociocultural tradition. The difference between Engeström's interest in collective learning and the report on collective learning provided by Van der Veen (2000), and Johnson and Johnson (2000) above, is Engeström's deeper engagement with how the sociocultural context and history *shapes* such emergent group-based learning interactions. This is an important aspect that is pursued in this present study. CHAT is a constructivist learning theory, but it also considers with some seriousness socio-historical, socio-cultural and socio-material factors (Fenwick, 2006), as does critical realism as discussed in section 2.5 below.

2.4 Transformative learning

Transformative learning has been described as the process where people gradually change their views following critical reflection and disorientation, or through disruptions of existing knowledge, experience, values or practices (Wals, 2007). Being confronted with dilemmas leads people to critical reflection and perspective transformation (Wals, 2007; Muro & Jeffrey, 2008; Belay, 2012). Hence, transformative learning foregrounds the issue of dissonance. I have not found literature that links this dissonance with changed practices per se; most literature seems to focus more on changed perceptions, which may or may not lead to changed practices. Engeström's (1987) and Engeström and Sannino's (2010) view of expansive learning was, however, focussed on expanding or changing human activity, which they saw as wider than changing of practices.

Van der Veen (2000) claimed that transforming perspectives can be a rather slow process as we progressively change our views of the world around us and of ourselves. However, he, together with other theorists (e.g. Wals, 2007), argued that such transformations of perspective can also occur in response to an externally imposed disorienting dilemma and thus, anomalies and dilemmas that cannot be explained by old ways of knowing become catalysts or 'trigger events' that precipitate critical reflection and perspective transformations. Van der Veen (2000) pointed out that "perspective transformation is an increase in our ability to handle more divergent facts and arguments and to reorganise these divergent facts and arguments into new convergent concepts" (p.18). He pointed out that people are more creative when they have a well-developed ability to reorganise paradoxical perspectives into a new convergent and innovative synthesis.

According to Driscoll (1994), there is no simple way to facilitate transformative learning, but some 'rules of thumb' do exist:

- create a learning climate that fosters critical thinking, and
- support the analysis of complex issues, by
- an active search for more information,
- comparing different perspectives on this information, and
- supporting individual learners to construct their own synthesis.

According to Van der Veen (2000), successful transformative learning may depend heavily on an individual's motivation to learn. Humanistic learning theory, as Van der Veen (2000) described it, holds that transformative learning happens when learning itself is related to the target of the learner to fulfil his or her potential. Thus, humanistic learning theory sees transformative learning as a form of self-realisation. This may differ in some ways to sociocultural learning theory, which views transformative learning (after Engeström, 2000) as an expansive process of social change (i.e. collaborative learning) of a shared activity. Van der Veen (2000) focused on humanistic and individualistic concepts of transformative learning, arguing that too radical transformative learning only seems possible if its elements, such as reflection, critical thinking and creating new syntheses, are present. How and if these elements are present and mobilised in collective learning situations can be of interest to the transformative social learning interest in this study. Further possibilities for theorising transformative social learning may be related to issues of collective dissonance, which Engeström (1987, 2001) and

CHAT have identified as tensions and contradictions in activity systems (see section 3.4.1). I discuss these aspects of CHAT in the next chapter. Critical realism also has insights that are helpful for thinking about transformative learning. In this study I have worked with dialectical critical realism which provides further depth and perspective on what Nunez (2014) described as the 'implicit ontology' of CHAT.

2.5 Critical realism

This section discusses the history of critical realism and the transitive and intransitive dimension. It further describes the key tenets of critical realism and discusses the understandings of causal power, explanation, and dialectical critical realism, as these provide further perspective for theorising and interpreting transformative social learning.

2.5.1 Critical realism: History and dimensions of relevance to this study

Critical realism is a philosophy of science that offers a meta-theory, which embraces ontological and epistemological perspectives describing structures, entities and mechanisms that make up the social world (Bhaskar, 1979, 1998). Critical realism, as applied to the social sciences, is associated with Roy Bhaskar's work and thinking which emerged after his first work *A Realist Theory of Science* (1975) in which he critiqued the epistemic fallacy and revindicated ontology in science. His point at the time was that scientific practice was too oriented towards the transitive and lacked a referent to the intransitive that is the real world. Following the first work on a realist theory of science which critiqued an over-reliance on either empiricism or transcendental idealism in classical modern sciences, his social sciences critique was published in a book called *The Possibility of Naturalism* (1979) and in this book he drew on Marx's theory of praxis to develop a transformational model of social activity which proposed that agency emerges from structure over time (Bhaskar & Hartwig, 2010).

Later, Bhaskar developed his philosophy further into what is now known as Dialectical Critical Realism, which is central to this present study and its interest in the processes associated with transformative social learning (see sections 2.5.5), the key work on this was published in a book called *Dialectics: The Pulse of Freedom* (Bhaskar, 1993). Bhaskar (in Bhaskar & Hartwig, 2010) described the development of this phase of his philosophy in relation to the earlier phases as follows:

> The simplistic way… is to think of basic critical realism as opening up the whole domain of ontology and dialectic as deepening that ontology by supplying concepts and exploring domains that were only presupposed at the first level. One way to see this deepening of

> ontology is in terms of what I have termed the 1M to 7Z/A Schema[5]… You move through first, the domain of 1M non-identity, which is also a domain of structure… [here] The object is not the same as the knowledge of the object, this is the transitive / intransitive distinction; then you have the distinction between the domains of the real, the actual and the empirical … 2E is the realm that is opened up by ***absence, but it includes the whole world of process, negation and transformation*** … at 1M you think of structure … at 2E you think it as a process. Then at a third, deeper level, 3L, you think being as a whole … by seeing internal relations between the different parts of being, not just external connections. Then at a fourth level, 4D … you think being as incorporating transformative praxis, agentive agency or intentional causality that effects material changes in the world … (pp. 123-124, my emphasis; see also section 2.5.5.4 below)

As can be seen from the citation above and the brief introduction to critical realism and its application to social science, the contribution of Bhaskar and his approach is relevant to this present research on transformative social learning, as he combines a general philosophy of science, transcendental realism, with the philosophy of social sciences, to interpret the interface among the natural and social worlds in his ontologically grounded dialectical movement from 1M (being, including nature, our biological beings and ecological life) to 4D agentive agency and praxis in what has also been termed a philosophy of 'transcendental realist critical naturalism' or 'critical naturalism' for short (Hartwig, 2010, in Bhaskar & Hartwig, 2010, p. 75). Drawing on the foundational work of Bhaskar, additional contributions have been made by philosophers and social theorists such as Norrie, Hartman, Archer, Sayer, and other critical realists. Bhaskar and Hartwig (2010) in reflecting on the progress of critical realism as a philosophy that seeks to 'work in the world' through resolving theory-practice inconsistencies, noted that critical realism is still relatively under-theorised and under-developed from an emergence point of view (i.e. ***how*** transformative praxis actually emerges from engaging with absence, negation and contradictions at 1M), and that there is need for further exploration and application of critical realism in different international contexts, for example as in the case of my study in Mozambique.

As can be seen from the above, my research is embedded in critical realism (CR) as applied within the social sciences and considers CR as a movement in philosophy and social sciences. My research is particularly interested in transformative social learning and its potential role in transforming irrigation practices as already outlined. Education or learning involves knowledge, and Bhaskar's philosophy differentiates between the transitive and intransitive dimensions. As noted by Bhaskar in the citation above, knowledge of the world is not the same as the world itself. Critical realists talk about an

[5] Note that in this thesis I only work with 1M-4D, as the last three steps at 5A, 6R and 7A/Z form part of the MetaReality phase of Bhaskar's work. In this study, I focus only on the Dialectical Critical Realist phase of Bhaskar's work as it emphasizes the *process of transformative learning and agency development within a collective social setting.* 5A-7A/Z focus on self reflexive human praxis and being as non-duality.

intransitive dimension, i.e. the object of inquiry, and a transitive dimension, i.e. our conceptions of that object. Burnett (2007) helped to clarify the differentiation between the intransitive and transitive object of knowledge in critical realism as follows and as adapted to my study's interest:

- The intransitive dimension consists of objects of knowledge that are in general invariant with respect to our knowledge of them. They are real things and structures, mechanisms, processes, events, and possibilities of the world and for the most part, they are fairly independent of us (Bhaskar, 1978). For example, the environmental system functions under certain mechanisms that we may not know but which may exist independent of our knowledge.
- The transitive dimension is seen as consisting of our knowledge of the world. For example, the knowledge that we have about irrigation systems or climate patterns (which is known to be uncertain). We are able to explain the existing structure and mechanisms behind irrigation systems management, which is the object of research in the learning field context of this study. We are also able to provide various explanations about climate change and its potential impacts on sustainable irrigation system management, even if this knowledge if fallible. Bhaskar (1978) argued that our knowledge of the world is often transitive, and it can change; thus, we can develop new knowledge of irrigation system management or we can improve our knowledge of climate change projections for example. This is because such knowledge operates in open systems that are always open to change.

Of further relevance to this study that works with a social-ecological object (community-based irrigation systems practice or activity), Burnett (2007) claimed that critical realists believe that human beings and their relationship exist in the natural world; as said by Bhaskar: "We are utterly dependent on nature. It is so important … and becomes crucial at the level of socio-political discourse generally … not just in terms of debates about ecology, but in terms of debates about the nature of reality" (Bhaskar & Hartwig, 2010, p. 103).

Social structures in critical realism are also understood as real changing things, which, as such, have their own qualities independent of our knowledge and understanding of them. Social structures must be discovered as they are not transparent (Burnett, 2007) and as such critical realism aims to interpret the world through depth-explanatory critique to surface absences, ills, contradictions and possibilities for change and emancipation. Bhaskar (1989) pointed out however, that the world cannot be rationally changed unless it is adequately interpreted, and critical realists must therefore engage in depth ontological explanatory critiques to surface absences, ills, contradictions and possibilities for change. In dialectical critical realism, critical realist researchers are also encouraged to engage with the processes of enabling agentive agency and transformative praxis, but Bhaskar's work does not provide a *learning-centred methodological process for this*; hence in this study I have worked with CHAT and social learning theory to complement the explanatory critique and the work of surfacing absences and contradictions in communal irrigation system contexts in Mozambique.

Corson (1991) noted that Bhaskar's entire project is concerned with emancipatory social practice, as for him the world cannot be changed rationally unless it is interpreted adequately; it is because he was unable to interpret economics in relation to the realities of the poor in his doctoral thesis that he developed critical realism, as modernist theory elided ontology. This interpretation has as its prerequisite the philosophical idea of the independent, yet related existence of natural and social worlds, and explanations and knowledge thereof (ibid*.,* as also explained above). Bhaskar's main theme is the nature of, and the prospects for, human emancipation. This perspective is expanding in educational research (e.g. Scott & Gough, 2003; Nunez, 2014; Price & Lotz-Sisitka, 2016) where many of the core concepts of critical realism are being worked with to develop emancipatory perspectives on education and social learning, as is also the aim in this study.

2.5.2 Key tenets of critical realism

According to Alverson and Skoldberg (2009), critical realism intends to provide a philosophic grounding for science as well as an alternative to positivist and interpretative/constructionist approaches. They further claimed that critical realism stresses the generalising task of scientific activity. This standpoint differs from positivism, as positivism is interested in predictable patterns. Instead, critical realists seek to identify the deeper underlying mechanism patterns of empirical phenomena. Bhaskar (1998) described this as a shift from epistemology to ontology. An important point that Alverson and Skoldberg (2009) made is that Bhaskar turns against what he understands as misleading and anthropocentric views, which give priority to epistemology and are, thus, concerned with what and how we are able to know. Bhaskar (1998) referred to this is as the 'epistemic fallacy', by which he means the tendency to conflate ontology and epistemology, and the confusion that exists with the knowledge we have about it (i.e. what we believe). Hedlund (2007) summarised the key tenets of critical realism. According to him, critical realists consider that:

- there is a world existing independently of our knowledge of it, and thus all knowledge is fallible;
- knowledge is transient and it is important to recognise that it is relative to the historical, social and political context in which it was produced;

- social reality entails that individuals both reproduce and transform social structures and that social structures, in turn, both shape and place constraints on individuals, while also being a result of continuous activity of individuals;
- human actions can be associated with unacknowledged conditions, unintended consequences, the exercise of tacit skills, and unconscious motivation;
- social structures are real things, which have causal powers that may or may not be activated.

Realism and interpretative social science both view social phenomena as concept-dependent and as things that need to be understood (Bhaskar, 1979, 1989). However, unlike interpretivism, realism argues that this does not rule out a causal explanation, because i) material change in society also needs to be explained, and ii) reasons can also be causes, as they prompt us to do things and think differently (ibid.). Thus, critical realism has a broader conception of causation and does not assume that all causes need to be physical (Sayer, 2000). Burnett (2007) noted further that critical realists recognise that because we are often shaped outside of our conscious awareness, it offers us a way forward through its emancipatory/transformational potential.

2.5.3 Domains of reality

Bhaskar (1998) argued that causal structures and generative mechanisms of nature exist and act independently of our knowledge of them, meaning that they can be structured and intransitive, and can be relatively independent of the patterns of events and the actions of humans and their interpretations thereof. He also argued that events must occur independently of the experiences in which they are apprehended. Structures and mechanisms are real and distinct from the patterns that they generate. Mechanisms, the events they give rise to, and experiences thereof are all real, but Bhaskar saw these three overlapping or stratified domains of reality, as shown in Table 2.3 below. Alverson and Skoldberg (2009) pointed out that the empirical domain is what we can observe, meaning things that happen and exist according to our immediate experience, for example, irrigation learning practices outcomes. The actual domain is a broader domain and includes that what transpires independently of the observer, for example, wider learning conceptualisations and understandings of irrigation systems and associations and management. The domain of real includes those mechanisms that are productive of different events, for example, causal powers of values or learning capabilities in irrigation system and respective associations that are or may not be exercised including the absenting of absences or ills, or the confronting of contradictions in irrigation systems and respective associations.

An important point is that critical realists see it as the task of science to explore the realm of the real and how it relates to the other two domains of the events and the empirical. Furthermore, Alverson and

Skoldberg (2009) argued that critical realists give more emphasis to the reality as such, as distinct from our conception of it, but also give attention to the conceptions of reality and how these change, which is potentially an interesting focus in learning-centred approaches to critical realism which seek to provide more insight into the *how* of transformative praxis and agency (Lindley, 2014; Mukute, 2010).

Bhaskar (1998, p. 34), argued that there is a distinction between the real structures and mechanisms of the world and the actual patterns of events that they generate. He explained that the world consists of mechanisms and not only events, and that it is "the combination of mechanisms that generate the flux of phenomena that constitute the actual states and events in the world, which we may consider as real". Bhaskar (1998) argued that causal structures and generative mechanisms of nature must exist and act independently of the conditions that allow people to access to them. Thus, they must be assumed structural and intransitive, i.e. relatively independent of the patterns of events and the actions. Also, the events must occur independently of the experiences in which they are apprehended. Thus, mechanisms, events and experiences constitute three overlapping domains of reality: the domain of the real, the actual and the empirical (see Table 2.3 below).

Table 2.3: Domains of reality

	Domain of real	Domain of actual	Domain of empirical
Mechanisms	✓		
Events	✓	✓	
Experiences	✓	✓	✓

Souce: Alverson and Skoldberg (2009)

Alverson and Skoldberg (2009) noted that mechanisms are a central point within critical realism. They loosely defined generative mechanisms as "that which is capable of making things happens in the world" (p. 42). They described how mechanisms exist, even when they are not triggered or when their effect cannot be traced, due to the effect of other mechanisms (ibid.).

Sayer (2000) explained that individuals, similarly, can do things because of their physical make up, their socialisation, their values, and education. They possess powers for work and learning even when currently unemployed or formally uneducated. Thus, realists seek to identify both necessity and possibility or potential in the world, e.g. what could happen, given the nature of the objects (ibid.), which is also an important focus for and interest in transformative social learning.

Sayer (2000) argued that "observability may make us more confident about what we think exists, but existence itself is not dependent on it" (p. 12). Thus, critical realists accept that things exist not purely by their observability, but also because there are causal powers associated with mechanisms; they have tendencies that can lead to interactions and emergence of diverse events and experiences (Collier, 1994). What is important in critical realist research is to recognise that powers may exist unexercised, and “hence what has happened or known to have happened does not exhaust what could happen or have happened” (Sayer, 2000, p. 12). Important for a study focussing on the possibilities of learning and change, Sayer (2000, p. 12) went on to state, “Realist ontology therefore makes it possible to understand how we could be or become many things which currently we are not: the unemployed could become employed, and the ignorant could become knowledgeable, and so on”. In this research, I understand that the socially real refers to practices, states of affairs, objects, or social structures (ibid.). Social reality entails causal mechanisms, rules, resources, powers, relations and practices some of which are exercised, and some which may potentially be exercised in transformative social learning and praxis developments in the context of irrigation scheme management.

2.5.4 Causal powers

Bhaskar (1998) noted that the real basis of causal powers is provided by the generative mechanisms of nature. The concept of generative mechanisms gives the real basis of causal powers that have nothing other than ways of acting, and causal laws must be analysed as their tendencies. Tendencies may be regarded as powers or liabilities which may be exercised without resulting in any outcome.

Powers are potentialities that can be exercised or not, and tendencies are potentialities which may be exercised or, as in play, without being realised or manifesting in particular outcomes. The causal laws are analysed as tendencies, tendencies are powers that can be perceived or not. Therefore causal powers cannot be analysed as simple powers; concepts of tendency and power are literally dynamised or set in motion. It is by reference not simply to the enduring powers but the unrealised activities or unmanifested (or incompletely manifest) actions of things that phenomena of the world are explained. In addition, generative mechanisms must exist and sometimes act independently of people and must be irreducible to the patterns of events they generate. In other words, they are 'intransitive' in so far as the mechanisms and causal structures, whose activity is designated, endure and act quite independently of men. Structures are intransitively structured in so far as it is the activities of mechanism and causal structures and not the occurrence of events that are designated in the statements of causal law.

A similar understanding is discussed by Sayer (2000) who argued that objects are, or are part of, structures. Structures are sets of internally related elements whose causal powers, when combined, are emergent from those of their constituents. Whether these powers are exercised, depends on other conditions. He gave an example: “the teacher's power to mark the work of pupils depends on his or her knowledge, qualifications, level of acceptance by the school”; this example shows the dependence of social structures on shared understanding in terms of acceptance of the teacher’s right to teach.

Sayer (2000) noted that in the open system of the social world, the same causal power can produce different outcomes, according to how the conditions for closure are broken and eventually different causal mechanisms can produce the same result. In the open systems of the social world, events are not pre-determined but depend on contingent conditions, therefore the future is open and eventually things may happen in many ways.

I have discussed an understanding of causal powers and generative mechanisms; next I discuss causal explanations.

2.5.5 Causal explanation

Bhaskar (1998) stated that critical realism is concerned with the possibility of causal explanation. Critical realists accept that relations in society are complex and that causality can exist on various levels. Causal mechanisms generate tendencies rather than inevitable, specific, measurable conditions. Critical realism examines the various mechanisms that have different implications in terms of different effects and events, and the intricate connection between different structural levels that contribute to the complexity of causal forces. Consequently, and importantly, causality should not be understood in terms of universal, predictable patterns, but rather as contextual and emergent patterns in changeable societies (ibid.).

According to critical realists, social reality is often slow in changing, but still emergent and varied as a consequence of the different processes and generative mechanisms that are producing it (Bhaskar, 1998). In uncovering typical patterns, while avoiding misconceptions of statistical predictability, critical realists sometimes use the expression *semi-regularity*, which indicates "the occasional, but less than universal, actualization of a mechanism or tendency, over definite region of time-space" (Bhaskar & Larson, 1998, p. 13). In addition, causal explanation depends on identifying causal mechanisms and how they work, and discovering in what ways they have been activated and under what conditions (see Chapter Seven).

Harvey (2002) has spoken about limits of naturalistic sociological explanation:

- social structures, unlike natural structures, do not exist independently of activities they govern;
- social structures, unlike natural structures, do not exist independently of the agents' conceptions of what they are doing;
- social structures, unlike natural structures, may be only relatively enduring, so that the tendencies they ground may not be universal in the same space-time invariant; these all indicate real differences in the possible object of knowledge in the case of natural and social science. (Bhaskar, 1989, p. 38)

Important for this research which focuses on community-based irrigation system activities and associated possibilities for transformative social learning, Bhaskar (1998) and Harvey (2002) called these three 'expectation dependencies' and they described naturalist explanation in the social sciences as being (i) activity dependent, (ii) concept dependent, and (iii) spatio-temporally dependent. This is explained further below:

(i) **Activity dependence** emphasises the fact that the law-like causal sequencing observed among social phenomena, unlike natural laws, are often influenced by the activity of the very agent whose conduct they daily regulate. From this it is possible to suggest that learning in irrigation systems is activity dependent, and irrigation operations occur through learners' actions that reflect learning in constrained systems to achieve efficacy, higher productivity and performance through their mediation tools, roles, subjectivities, divisions of labour and so on, as proposed in CHAT (see sections 4.2 and 5.2). In critical realism, activity dependency would require an understanding of the generative mechanisms shaping the activity, and an understanding of the potentially undetermined nature of roles and statutes when they enter concrete reproductive or transformative activities. In addition, activity dependence implies the need for a process that involves motives and goals for actions associated with the activity, which can shift according to situational demands. It could also imply reflexive monitoring of activity and own life situation reflecting capability for judgment.

(ii) **Concept dependence** underlines the fact that the orderly enactment and reproduction of institutional programmes is contingent on skilful individual agent's interpretation and implementation of institutional plans. It delimits the use of naturalistic paradigms in constructing deterministic accounts of agency's role in reproducing institutional beings.

(iii) **Spatio-temporally dependant activities** are generated via a complex constellation of generative mechanisms that lead to diverse events and empirical experiences in diverse spatio-temporal configurations. For example, the generative mechanism of water scarcity and climate change may not influence two irrigation systems in the same way as there may be other generative mechanisms influencing the case contexts, such as people's values, or power relations with big business. Thus, it is possible to anticipate that irrigation scheme activity, even though it is supported by the same policy in the same country, is likely to be very different in different community-based contexts. Because of this constantly emerging complexity and the role played by human interventions, powers are not always exercised in a constant manner across time or space. At the same time, social structures and institutions are time-dependent constellations, i.e. they have evolutionary life histories of their own, they are subject to temporal cycles, growth and decay. In both the short-term and the long-term, social institutions are spatio-temporal dependent in their ability to influence human conduct at any given time and place. In addition, spatio-temporality has to do with the steps to be implemented when striving for long-term goals, for example, while dealing with sustainability.

In this section I have discussed causality and emergence following Bhaskar's thinking as it relates to stratified ontology and emergence in the social world as this is important for understanding being, or the way in which the irrigation activities are and have come to be the way they are. In the next section, I discuss dialectical critical realism more concretely with a focus on the dialectics of absenting absences or ills as this is important for understanding how the irrigation activities could be, or how they might change, via transformative social learning processes.

2.5.6 Dialectical critical realism

Bhaskar's (1993) dialectic has four terms: non-identity or being (IM), negativity signalling absence (2E), totality signalling relational possibility (3L), and praxis 4D signalling agency and becoming (transformative praxis). The following description of these terms is based on Norrie (2010).

- ***First moment (1M) - Non-Identity***

This involves the understanding of the stratification and differentiation of the world, with its real causes and generative mechanisms (Bhaskar, 1993). For transformative social learning research, this means identifying real causes and structural mechanisms that influence the learning of new irrigation scheme management practices in the activity systems.

- ***Second edge (2E) - Negativity***

This entails the identification of 'real negativity' and contradictions, and things that are absent. Something may be absent from a spatio-temporal region (e.g. available irrigation system technology may exist elsewhere, but be absent from the community irrigation scheme sites in Mozambique); or because it does not exist at all (e.g. appropriate sustainable technology for the irrigation schemes may not have been invented or developed yet). The absence of something may have causal effects on objects in the relevant space-time region. An example would be a technology that is not effectively transferred, affects how an irrigation scheme works or not (Bhaskar, 1991, cited in Norrie, 2010). According to Norrie (2010), "the world, including the natural world, contains absences, omissions, liabilities, just as much as presences, commissions and powers" (p. 14). Thus, for transformative social learning research, it may be important to identify absences, omissions, liabilities affecting the activity systems, as well as the 'presences, commissions and powers'. *Absence* is a key concept in dialectical critical realist research. Dialectic, at is most complete, involves "the *absenting* of constraints or the *absenting* of *absences*, or ills' (Bhaskar, 1993, p. 396, emphasis in original). This discussion of absences also indicates that which is present (e.g. an irrigation scheme committee) is a "tiny, but important […] ripple on the surface of a sea of absence" (ibid.). Absences include those things that are erased, hidden, omitted, forgotten or excluded. In Engeström's (2001) expansive learning process (see Chapter Six), he emphasised the development of *model solutions* to respond to contradictions and tensions that arise in activity systems, but he did not explicitly couple this with *absenting absences*, although such a process may be implied. Working more explicitly with the idea of absenting absences through model solutions may enhance the transformative intent of the expansive learning processes in the context of the irrigation scheme development. It may also help to identify ongoing possibilities for transformative praxis in an irrigation scheme's ongoing development (goal two and three of the present study).

- ***Third level (3L) - Totality***

This involves relating the negativity or absence, as identified at 2E to *totality,* which entails the wider possibilities for how things might be. This allows for the dialectic to be engaged. Norrie (2010) explained that Bhaskar's work developed a crucial link between *absence* as *ontologically real,* and *absence as negation*. Norrie (2010) argued that this is important as it shows the dynamic nature of the world, and that processes of change are possible. Norrie (2010) claimed that it is at this level that the "processural categories of negation, contradiction, development, becoming, emergence [transformation?]" (p. 15) are important. For transformative social learning research, these processes of negation, contradiction, development, becoming and emergence and transformation would seem to be important to monitor and understand. The methodology of CHAT (see Chapter Three) encourages identification of contradictions, development and emergence within the expansive learning process. Through critical realist work it would seem possible to add an emphasis on negation and absenting absences to this process to strengthen its transformative intent.

- ***Fourth dimension (4D) - Transformative praxis***

Transformative capacity is concerned with practical human *agency* to change the world, or "agential ethical praxis" (Norrie, 2010, p. 15). This involves acting according to ethical positions of "what it means to be free and to enter into relations of solidarity with others", which could also include the environment on which we depend, as is reflected in sustainability thinking (ibid., p. 17). The sustainability and participatory concepts used in this present study establish an ethical direction for the irrigation system management practices. However, Norrie (2010) argued that while these concepts set ethical direction, they should be contextualised in practices that matter to people (e.g. poverty alleviation practices). Giving attention to these ethical questions in the social learning processes may also influence the way in which transformative social learning is conceptualised, understood and monitored.

2.5.6.1 Dialectics of absenting absences

Bhaskar (2008) pointed out that dialectics is at the heart of every learning process … ontic change and hence absence must occur in a world containing human agency. Epistemic change must be possible and is necessary too…. meta-epistemic change must be possible when changing beliefs and conceptions.

Bhaskar (1998) has indicated that the category of absence in dialectical critical realism is pivotal to 1M-2M links in his dialectical schema. Thus, a 1M non-identity or alterity may generate a 2E absence, causing a 3L alienating detotalisation or split-off resulting in a fragmented impotent self, or to a 4D transformed transformative totalising praxis absenting the split. From 1M-4D links, in which 2E absence/absenting is the key mediation between 1M non-identity, 3L totality and 4M agency, which, as its prototype, the absenting of absence is a manifestation of desire for change. Dialectics depend upon the satisfaction of positive identification and transformative elimination of absences, which essentially means the process of absenting absence or ills, which often also manifest as contradictions (ibid.) (see Chapter Seven).

Bhaskar (1998) explained that *real negation* is considered to be the presence of an absence in a more or less determinate region of space-time (comprising, as a relational property of the system of material things, an objective referential grid, of an absence at some specific level or context of being more or less determinate entity, thing, power, event, aspect or relation). Real negation can be perceived most simply as absence, or, qua process, absenting. Absenting processes are crucial to a dialectic convinced of the logic of change - which is absenting (see Chapter Seven). *Absenting absences* (e.g. the absenting of an absent functioning irrigation association) acts to address constraints on wants, needs, or well-being, and the argument on which dialectic has been traditionally modelled, is to absent mistakes. Bhaskar's (1993) point is that all causal determination, and hence change, involves transformative negation or absenting and this occurs in particular space-time configurations. Bhaskar's (1993) dialectic, unlike the Hegelian dialectic on which CHAT is based, foregrounds absence.

In this research, I pay attention to absences that may be found in irrigation system activity and their relationship to expansive learning processes and the ongoing potential for transformative learning; as this can potentially provide a way of linking individual, collective and societal goals for transformative social learning. At a broader level, the emphasis on sustainability in learning for sustainability in some ways denotes an absence that requires ongoing attention in social learning processes, signalling transformative intent. Hence, developments in the field of Environmental Education that are related to learning for sustainability are also relevant to this study, particularly if sustainability is seen as a general absence, in the way that irrigation scheme developments have emerged, and may emerge. However, in interpreting sustainability as an absence (at 1M), it is also important to consider Bhaskar's point about natural necessity and real ethical praxis, which requires contextualisation of the notion of sustainability to the Mozambican community context at the level of transformative praxis (4D), while understanding its importance at a wider global level (2E and 3L).

2.5.6.2 Emergence

According to Bhaskar (1998, p. 49),

> Emergence entails both stratification and change … if, … all changes are spatio temporal, and space-time is a relational property of the meshwork of material beings, this opens up the phenomena of emergent spatio-temporalities. There are two paradigms here, both instantiated in reality: (i) they could be relata of a new (emergent) system of material things, and/or (ii) they could be new (emergent) relata of a pre-existing system of material things. In either event they establish new 'rhythmics', where a rhythmic is just the spatio-temporal efficacy of the process.

Applied to the context of irrigation scheme management activity, this could mean that the changes that emerge could be related to the new emergent system of community-based irrigation scheme developments (i.e. the new material / social-ecological system that is being developed) as envisaged by policy in Mozambique, or the changes could be related to curriculum or training that is based on an old, established pre-existing system of material things (the way training is organised and structured for extension services). Both types of changes would be spatio-temporally defined, as explored further in this thesis. Bhaskar (1998, p. 50) stated further that "emergent social things are existentially constituted by or contain their relations, connections and interdependencies with other social (and natural) things" thus changes in an irrigation scheme development would be related to other social things (e.g. the training system, or the financing system, or the geohydrology of the area for example. In CHAT, a similar emergent relational view is adopted between and within activity systems (see Chapter Three) which proposes that activities are historically and culturally situated and shaped over time in specific space-time configurations. As Bhaskar (ibid., p. 50) stated "… although we may live for the future, we live quite literally, in the past". Thus, emergence is historically and ontologically defined, but it is not reduced to the past or existing being, as agents have powers to exercise reflexivity and change the conditions under which they find themselves. Engeström, via CHAT, argued that such changes are possible via expansive learning which uses contradiction as the focus for expanding learning (i.e. emergence). Bhaskar has commented on conceptual emergence, and suggested that this can occur via dependence on the past or on exterior cognitive resources (e.g. a training programme). It can also, he suggests "be effected by means of a perspectival switch, the formation of a new Gestalt, level or order of coherence without any additional input" (p. 50) which is similar to the cognitive transformations envisaged from learning as outlined by Mezirow (1997). However, Bhaskar's concept of emergence is not only related to cognitive emergence, but also to agentive agency and the emergence of transformed praxis.

2.5.6.3 Contradiction

Bhaskar (1998) noted that in the Hegelian dialectic, logical contradiction plays the 'motive force' in leading the expansion of the existing conceptual field. Bhaskar, however, critiqued the Hegelian dialectic by juxtaposing Marx to Hegel and through this, he showed that "… logical contradiction is not the same as dialectical contradiction, although the two classes intersect" (Bhaskar, 1998, p. 51). He went on to say that "not all dialectical connections are contradictory and not all dialectical contradictions are or depend upon logical contradictions in the way I have argued Hegel's paradigmatically do" (p. 50). He defined contradictions as follows:

> The concept of contradiction may be used as a metaphor (like that of force in physics) for any kind of dissonance, strain or tension. However, it first assumes a clear meaning in the case of human action, which may then be extended to goal-oriented action, and thence, by a further move, to any action at all. Here it specifies a situation which permits the satisfaction of one end or more generally result only at the expense of another: that is, a bind or constraint. An internal contradiction is then a double-bind or self-constraint (which may be multiplied to form a knot).

Internal contradictions and their associated change possibilities are directly situated by the phenomena of emergent entities and as such, dialectical contradictions are not per se logical contradictions. According to Bhaskar (1998, pp. 53-54),

> Dialectical contradictions are, like logical contradictions, also a type of internal contradiction. They may best be introduced as a species of the more general category of dialectical connections. These are connections between entities or aspects of a totality such that they are in principle distinct but inseparable, in the sense that they are synchronically or conjuncturally internally related, i.e. both (some, all) or one existentially presuppose the other(s) … Dialectical connections, including contradictions, may hold between absences and absentings as well as positive instances and processes, and the causal connections and existential dependencies may be transfactual or actual. Real dialectical contradictions possess all these features of dialectical connections … But their elements are also opposed, in the sense that (at least) one of their aspects negates (at least) one of the other's, or their common ground or the whole, and perhaps vice versa, so that they are tendentially mutually exclusive, and potentially or actually tendentially transformative.

Bhaskar (ibid.) reflected on what makes dialectical contradictions 'necessarily radical' in his theorising of the dialectic. He suggested that the 'real' definition of the contradictions is crucial to the transformative nature of the dialectic. This means that researchers must make the effort to produce explanatory critiques of situations that reveal the nature of the contradictions at the level of the real, i.e. the deep structural / generative mechanism level. This is significant for working with CHAT, as CHAT also works with contradictions as the focus of expansive learning and for such learning to be transformative, the contradictions and absences must be identified at the level of the real. Bhaskar (ibid., pp. 55-56) suggested further that

> Dialectical contradictions may be more or less antagonistic, in the sense of expressing or representing or even constituting the opposed interests of (or between) agents or collectivities; and, if antagonistic, they may be partial or latent or rhythmically dislocated, and manifest to a greater or lesser extent in conflict, which in turn can be covert or overt, transfactual or actual, as well as being conducted in a variety of different modes … The grounds, structures or mechanisms which generate real dialectical contradictions may themselves form recursively (geo-historically variable componential), hierarchical, $power_2$ -dominated, complexes or totalities.

According to Bhaskar (1998), critical realists are most concerned with internal contradiction, and with dialectical contradictions that are multi-facetted as described above. Moving from act identification to object identification, Bhaskar made a parallel argument. This is that we can grasp objects by reflecting on what they are not, as well as on what they are. This argument is concerned with the role of absence

– in the (epistemological) act of identification, in the (ontological) constitution of the object and in the (practical) causal changing of such objects.

2.5.6.4 Agency

The dialectic as described above, is also closely linked to agency in critical realism, as shown by the 1M to 4D schema of dialectical critical realism.

Bhaskar suggested that absenting absence through transformative praxis involves agentive agency, and that this is associated with increased freedoms and flourishing, especially when such acts of agency are also addressing $power_2$ (structural power) relations that are hampering people's capabilities and / or flourishings, or the flourishing of all. As stated by Bhaskar (2008, pp. 40-41),

> … change involves transformative negation; and hence absenting, most notably of constraints on desires, wants, needs and interests. Foremost among such constraints will be those flowing from $power_2$ relations … Thus the definition of dialectic as absenting absence; and, since all ills can be seen as absences and absences as constraints, as absenting constraints. Furthermore, since all lack of freedoms can be seen as constraints (and vice versa), the definition of dialectic as absenting absentive agency, or as the axiology of freedom.

According to Bhaskar and other critical realist theorists such as Archer (1995), society is both the condition and outcome of human agency, both for the production and reproduction or transformation of society. At the heart of this conception of agency as material causation is the idea of human agency or praxis as transformative negation of a given thinking or practice. At the same time, such agency and change activity is both enabled and constrained by and is reproductive or transformative of the very conditions of praxis. Such conditions are activity-dependent or "autopoietically conceptualized (concept dependent but not exhausted) and geo-historically dependent (and thus themselves are the possible object of transformations)" (Bhaskar, 1994, pp. 92-93). Bhaskar (1998, p. 259) emphasised what he called 'embodied agentive agency' by which he meant that human agency cannot only be posited as 'reasons for acting', but must recognise situated human reflexivity and "intentional embodied agency with distinct (emergent) causal powers from the biological matter out of which agents were formed, on which they are capable of reacting back (and must, precisely as materially embodied causally efficacious agents, do so, if they are to act at all)" (ibid., p. 47). However, he cautions that such agency takes place in "open-systemic totality" and such agency is, while shaped by structures and generative mechanisms, not determined wholly by these antecedents (p. 47). For transformative social learning oriented towards transformative praxis, this would mean taking account of people's agency in the irrigation schemes, especially their 'embodied agentive agency' as referred to by Bhaskar (i.e. what they are doing and how they are reflexively changing / able to change their practices). According to Bhaskar (1998, p. 216),

> …. Society must be regarded as an ensemble of structures, practices and convections which individuals reproduce or transform them, but which would not exist unless they did so. Society does not exist independently of human activity but is not product of it and the process whereby the stocks of skills, competence and habits in appropriate given context, and necessary for reproduction and/or transformation of society, are acquired and maintained and could be referred as socialization …

The institutional assembly of the community (or activity systems according to CHAT) is the yard in which personal identities, social structures, and reproductive or transformative mediations are basically constructed. In such a context, people with language, dispositions, relations, knowledge, experiences, beliefs, cultures and values interact with the word, transforming it, and through this, create their own possible paths of future realisation.

Also relevant to the interest in transformative social learning and changes in practice, is the point that Bhaskar (1998) made about reasons: reasons can be causes and reasons are also beliefs. As beliefs can be specified disinterestedly, that is in isolation from desire, this can partly account for systematic ambiguity in the notion that people may not act, if they don't expect any change or if they are satisfied or if they won't experience added value from the action. For my study, this would mean that I need to give attention to reasons, and beliefs of community members in relation to their participation, learning and agency in the irrigation scheme activity as these have causal powers in agency formation and transformative praxis potential.

2.6 Synthesis

In this chapter I have approached the ontological and epistemological concerns regarding transformative social learning, which includes a discussion on social learning and critical realism to access and interpret learning processes, transformation and agency within irrigation systems and respective associations. For my research on the irrigation scheme association activities, I have assumed that learning within irrigation systems occurs and that absences and dialectical contradictions are a source of learning, emergence transformation (agency and praxis) as will be further explored in the next chapter and the rest of the thesis. As argued in this chapter, theories of social learning appear to require further development in terms of clarifying how such learning can be seen to be transformative (or not). Bhaskar's dialectal critical realism provides an underlabouring philosophical perspective on this question, and proposes that engaging with stratified reality, the differentiation of the transitive and the intransitive (our knowledge of the world, and the world), absences, and processes of transformative negation (1M to 4D) in which absenting absences or ills (as represented in the dialectical contradiction) can provide a way of thinking through the possibilities for transformative social learning in irrigation scheme developments. However, while Bhaskar's work provides such a schema, it does not provide a learning theory, or a process methodology for guiding such forms of transformative, expansive learning, which I discuss in the next chapter in more detail.

CHAPTER THREE

Methodology and Cultural Historical Activity Theory

3.1 Introducing the overall study design

This chapter introduces the study design and methodology. It provides an overview of the research design which includes four main processes, as presented in Table 3.1 below. Each research process is designed to address one of the research goals and their associated questions, which collectively will address the main research question. The chapter also deals in more detail with cultural historical activity theory as it provides the main methodological process framework for the study, and the modes of inference used for critical realist analysis, including inductive, abductive and retroductive modes of analysis. As indicated in Chapter 1, the research was constituted as case study research involving two community-based irrigation schemes in Mozambique.

Table 3.1: Research design

Goal 1 (Phase 1)	Activity system analysis using third generation activity theory. This involves three interrelated activity systems in each of the case study sites. The contradictions, tensions and absences between the activity systems (and their generative mechanisms) are documented for use in the expansive learning phase of Goal 2 (Bhaskar's 1M).
Goal 2 (Phase 2)	Active engagement with and facilitation of an expansive social learning process using Developmental Work Research, following the expansive learning cycle, including a focus on absenting absences (Bhaskar's 2E-4D).
Goal 3 (Phase 3A)	Inductive-abductive analysis of transformative social learning processes using consolidated theory of transformative social learning.
Goal 3 (Phase 3B; also linked to Goal 1 and 2)	Retroductive analysis using Bhaskar's concept of absence in dialectical critical realism to identify further transformative social learning opportunities (note that this analysis was conducted in tandem with Goal 1).

3.2 Case study research, case study framing, and specificities of each case

3.2.1 Some general perspectives on case study research relevant to this study

This research is problem-driven and quantitative and qualitative data is used where relevant. Although the primary mode of data collection and analysis is qualitative in nature, quantitative data is used as a secondary source to provide contextual data for insight into some aspects of the context. This study will use a collective case study approach (Stake, 2005), with the aim of reaching an in-depth description, analysis and explanation of specific and generic properties of (transformative) social learning in two cases of irrigation system development at community level in Mozambique.

I have chosen case study as a research strategy considering that case studies are used in many situations to contribute to knowledge of individual, group, organisational, social, political and related phenomena (Yin, 2003), especially where these involve complex social phenomena. A case study approach allows for analysis of a wide variety of evidence: documents, artefacts, interviews and observation. In general, within the realism paradigm, a case study methodology is preferable when:

- there are particular events that focus on a situation or context (Merriam, 1988; Eisenhardt, 1989);
- social organisational settings are intricate (Morgan & Smircich, 1980);
- the researcher seeks contextual meaning within a bounded system (Stake, 1978; Bonoma, 1985; Yin, 1989); and
- the research enterprise involves inductive theory building (Gilmore & Carson, 1996; Hirschman, 1986; Merriam, 1988) or abductive inferences which recontextualise theory or wider contextual features (Danermark, Ekstrom, Jakobsen, Karlsson & Bhaskar, 2002);
- researchers aim to engage with research participants in specific contexts to generate and support change oriented practices or activity and where in-depth knowledge of contexts, activities, and changed practices or transformative praxis is sought (e.g. Mukute, 2010; Belay, 2012; Lindley, 2014; Kachilonda, 2014).

According to Flyvberg (2011), doing case study research is not only a methodological choice, but also an important choice about what to study, i.e. what the bounded unit is that forms the case. Flyvberg (2011), together with other case study researchers such as Stake (2005), claimed that case studies may be studied in various ways, using a range of different methods or even methodologies. The researcher has to make decisions about what types of data are most useful to inform a case, and how these can be generated. In this study, most of the data was generated within the CHAT framework and expansive learning processes, as outlined in sections 3.3.1 and 3.3.2 below and using techniques such as document analysis (for historical records); interviews and focus groups (to access people's views and thoughts); and observations (to document what is happening in practice), as outlined in section 3.5 below. Moreover, Developmental Research Workshops or Change Laboratory Workshops were used as part of the case study development, as described in section 3.5.3 below, and in Chapter Six.

This research involves both the analysis of, and, as a developmental work researcher, active engagement in two cases of expansive learning. Bickman and Rog (1998) and others cited below argued that there are fundamental research purposes that make qualitative case studies useful, which include:

- Reaching an understanding of the meaning, for participants in the study, of the events, situations, and actions they are involved with, and of the accounts that they give of their lives and experiences. With such a focus, researchers are not only interested in physical events and behaviours, actions or activities but also how the participants in the research study make sense of these, and how their understanding influences their behaviour, actions or activities. Important here is the focus on perspectives on the events and actions to be accessed in terms of truth or falsity. As noted by Maxwell (1992), these are part of the reality that one is trying to understand, a point which resonates with Bhaskar's (1998) empirical level of the real (see section 2.5.3);
- Understanding the particular context within which the participant acts, and the influence this context has on their action. Qualitative studies are able to provide detailed and nuanced understandings of how events, actions, and meanings are shaped by unique circumstances in which they occur;
- Identifying unanticipated phenomena and influences, and generating new "grounded" theories about the latter where relevant;
- Understanding the processes that are involved in the events and actions that are taking place; and
- Developing causal explanation. The traditional view that qualitative research cannot identify causal relationships has long been disputed by some qualitative researchers (Denzin, 1978), and both qualitative and quantitative researchers are increasingly accepting the legitimacy of using qualitative methods for causal inferences (e.g., Cook, Leviton & Shadish, 1985; Maxwell, 1996; Miles & Huberman, 1994; Mohr, 1995, 1996; Sayer, 1992). Deriving causal explanations from a qualitative study is not a straightforward task, and in this research I have drawn on

critical realist modes of inference, namely induction, abduction and retroduction to engage with causal explanation, as is possible in critical realism (namely the possibility of providing fallible, yet relatively certain causal explanations at the level of generative mechanisms or tendencies). This is different from the Humean correlational foundations of causal explanations, which I do not use in this research as they have been critiqued as being positivist (Price, 2007). In critical realist causal explanations there is a need to deal with the plausible validity threats to any proposed causal explanation, which I discuss in section 3.9.

3.2.2 Case study framing in this study

As already mentioned and introduced in Chapter One, the two case studies that make up this research are irrigation system developments in the Massaca and Macubulane irrigation associations. In each case, I include a description of the socio-ecological system and analysis of the activity systems and their expansion within a transformative learning framework as explained in Chapters One and Two.

3.2.2.1 Irrigation socio-ecological context

A key feature of my case study descriptions includes description of key features of the social-ecological context of each case study site (as presented in sections 3.2.2.1 and 3.2.2.2., and as expanded on in Chapters Four, Five and Six). A socio-ecological system can be described as complex system composed of biophysical and social components in which individual resources are influenced by physical infrastructure and institutional structures and processes which affect the way the system functions over time, including the way in which it copes with disturbances (Anderies, Janssen & Ostrom, 2004). Irrigation systems can be typified as socio-ecological systems that include the ecological and physical capital (e.g. the hydrological system), the infrastructure (e.g. canal dykes, head works influencing the hydrological system), and social capital (e.g. rules that influence the behaviour and activity of individuals and groups). Physical infrastructure and ecological conditions affect the water availability flowing in the canals or pipes. Social/institutional infrastructure affects how much water is allocated to each farmer and the resources that the farmer must invest in the system. The nature of social aspects and physical infrastructure affects the likelihood of the socio-ecological system to engage with sustainability concerns in a particular environment. Following this, it is possible to suggest that social and ecological conditions and arrangements may influence the learning processes in socio-ecological systems, such as irrigation systems. All these aspects have been included in the case study descriptions in this research.

Anderies et al. (2004) identified five main components of socio-ecological systems, namely (i) resources (e.g. soil and water), (ii) resource users (e.g. the farmers), (iii) public infrastructure providers (e.g. policy makers), (iv) public infrastructure (e.g. social and physical capital), and (v) external environment (e.g. biophysical disruptions and floods. Accordingly, in irrigation systems:

(i) *Resources* are mostly biophysical systems or natural and capital resources that are used by farmers, such as soil and water.

(ii) *Resource users* are the farmers who use the resources of the irrigation system. They need knowledge on how to run the system in a sustainable manner and how to deal with internal and external disturbances, such as a lack of water.

(iii) *Public infrastructure providers* are those who have a monitoring task, contribute labour or make policies on how to invest these resources in the construction operations and maintenance of the irrigation system. These include extension services and state or para-statal agro companies.

(iv) *Public infrastructure* combines physical and social capital. The physical capital includes a variety of engineering works including the physical irrigation structure. Social capital includes the rules that are used to govern, manage and use the system. These rules create opportunities and constraints in the action-outcome linkages available to participants. This also includes monitoring and enforcing these rules, and the way farmers have learned irrigation practices.

(v) *External environment* includes biophysical disruptions, floods, and climate change that may cause socio-economic changes, including well-being of the farmers and change in profitable opportunity.

This study is concerned with the activity systems associated with community-based irrigation, which is embedded in the socio-ecological system. Sources of learning may arise from internal disturbances in such a context, as farmers try to achieve a sustainable irrigation infrastructure, farming outcomes and improvement of productivity. Table 3.2 provides insights into the entities involved in the cases of community-based irrigation management, as identified for this study.

Table 3.2: Entities involved in socio-ecological systems

Entities	Examples	Examples of potential contradictions	Examples of issues for learning
Resources	Water source	Uncertainty	Learning to deal with uncertainty, deal with water quantity and quality
Resources users	Peasants using irrigation	Free-riding in crop management and maintenance, irrigation, not paying fees	Learn to develop norms, monitoring
Public infrastructure providers	Executive and council of local users association and private institutions	Internal conflict or indecision about which polices to adopt, water supply, contracts	Learn to develop adequate norms
Public infrastructure	Engineers work and institutional rules	Equipment degradation, deliberate cheating	Learn to develop adequate norms
External environment	Weather, economy, political system	Sudden changes as well as slow changes, e.g. soil salinisation	Learn to deal with shocks

3.2.3 Actual case study site descriptions to show the configuration of the social-ecological system, and stakeholders and participants involved in the study

3.2.3.1 Macubulane irrigation association

As briefly introduced in Chapter One, the Macubulane irrigation association is located in the Magude district in the Maputo province within the Incomati River basin. Features of the social-ecological system in this case study includes the following dynamics which make up the framework for the case:

- The soils are sand-clay, which is suitable for sugar cane production considering that the water retention is medium.

- The Macubulane irrigation association operates an irrigation system that comprises an area of 187 98 ha, and each member holds a plot of one hectare. Water is supplied from the Incomati River; this is sufficient during the year to supply the system via three electro-pumps.
- The water quality in the Incomati basin is suitable for irrigation. I measured the water quality using Waterproof Dissolved Oxygen Meter Model 9150: DO2 and Temperature and EDT instrument FE 287 Micro conductivity: conductivity, TDS, Salinity and Temperature in the intake water for Massaca irrigation association in the Umbeluzi River basin. The results of the test are shown in Table 3.3. If analysed according to the permissible value of FAO water quality for irrigation development, the water can be used for irrigation purposes.

Table 3.3: Water quality measured at Incomati river basin water intake to Macubulane fields

Location	36 0468742	
Parameter	Data obtained	Permissible value (FAO)
T	24°	
TDS	743 mg/L	450-2000
DO2	8.7 m/l	
turbidity	good	
PH	7.9	6.5-8.4

- The association has 200 members that practise sprinkler irrigation methods and sugar cane production. In initial interviews, members said that before its establishment in 2005, each of them had their own plot and each produced different crops, such as maize, tomatoes, for subsistence. Members did not have pumping water systems to collect water to the field, and member farming benefits were low. Thus, some farmers simply practised rain-fed agriculture. Figure 3.1 shows the map in Macubulane irrigation association where the valves are located as intake of water for sugar production, connected in six main blocks (A, B, C, D, E, F).

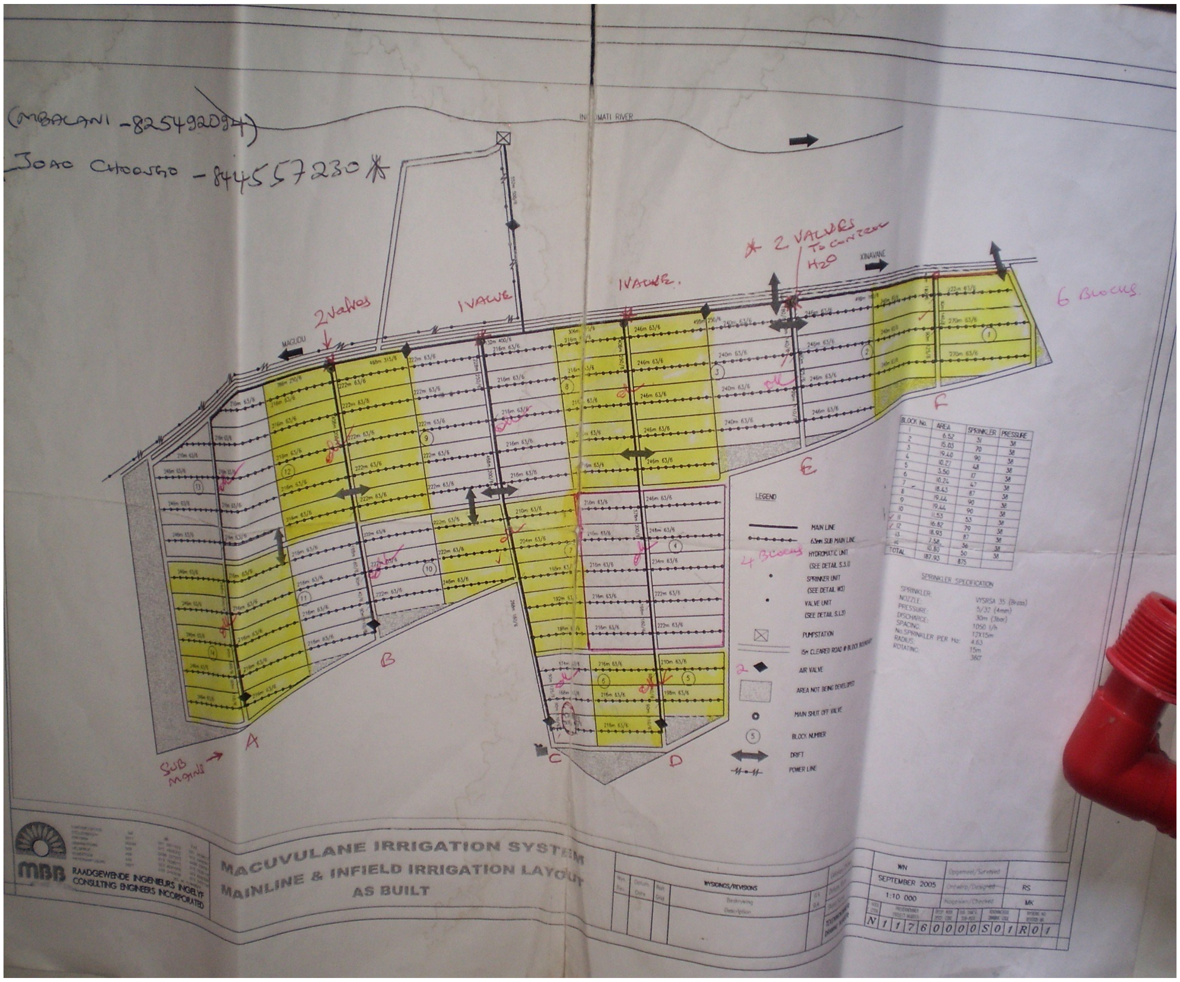

Figure 3.1: Map of Macubulane irrigation systems

- In 1999, there was a project to stimulate the production of sugar cane and the farmers organised themselves in a sugar cane irrigation association. This was followed by a process in which some members of Macubulane organised themselves and invited farmers to join the association. Initially, members said in interviews, these were not easy processes, but when surrounding communities were seen to be moving to sugar cane production and profiting from this, the Macubulane members also became interested.
- In 2005 the Macubulane irrigation association was established and started to produce sugar cane and sell it to the Xinavane Sugar Cane Company. This process demands for expansive learning in irrigation activity systems, which are further discussed in this chapter and in Chapter Six.

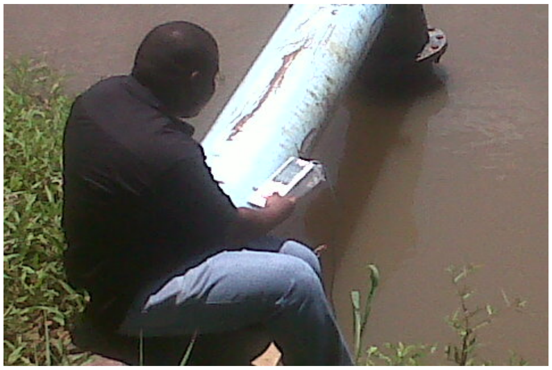

Figure 3.2: (a) Measuring water quality **(b) A sugar cane plantation in Macubulane**

- The main stakeholders of the association include the local agriculture ministry representative (SIDAE), the Incomati Sugar Cane Company, the Agribank, and the Agrarian Institute, Agrarian technical schools. The way in which these institutions work with the associations is discussed in Chapter Four, in which activity systems in this irrigation association are discussed for Macubulane case.
- The Macubulane irrigation association statutes have the following structure: (i) general assembly, (ii) management board, and (iii) fiscal board. The Macubulane irrigation association general assembly is composed of all members, while the management board is composed of the President, Vice-President, Secretary, accountant, and two vowels. A vowel is a figure that according with association status have to collaborate with all Management board. The fiscal board is composed of the President, secretary and rapporteur. The process of interactions on all these levels drives learning processes, which are further discussed in Chapter Four.
- Farmers practise sugar cane production using a type of sugar cane known scientifically as *Saccharum Officinarum*. Their production is managed via an outsourcing system which involves the Incomati Company (a sugar cane company), meaning that what the farmers produce is sold to a sugar company that mills it to produce sugar. The Incomati Company buys the sugar cane of the association Board and the association Board pays the individual farmers. Following the internal rules of the association, running cost are deducted and the rest is divided equally between all members of the association. The running costs of the system include: power, water, salaries for managers, accountants, and repair of equipment.

Through the processes described above, the farmers started to try new forms of farming changing from a rain-fed to an irrigation system, from simple cropping of vegetables to sugar cane production, and from subsistence to commercial farming. This frames the case study, as reported on in Chapter Four and in Chapter Five.

3.2.3.2 Massaca irrigation association

As briefly introduced in Chapter One, the Massaca irrigation association was founded in 1996 in the Boane district in the Umbeluzi catchment. The features of the social-ecological system that make up the framework of this case are:

- The river has enough water throughout the year. Even in the drought season there is no water shortage. Water for the irrigation scheme is released from the Pequenos Libombos Dam, which also supplies Maputo city, about 40km away.
- The irrigation system comprises three perimeters: lower, middle and higher. These are constituted of a group of plots, drifts and hydrants whereby water is delivered to respective plots of 80x80m^2. Water is collected from the Umbeluzi River via a pumping station using five electrical water pumping machines from the valley down to irrigation system.
- This association practises surface irrigation using gravity/flood irrigation methods (section 1.3.6). The water released from the dam is 2m^3 although the scheme only needs 0,26m^3. The quality of the water used for irrigation in Pequenos Libombos Dam is good, as can be seen in Table 3.4 which depicts some indicators of water quality for irrigation.

Table 3.4: The water quality of the Umbeluzi River basin

Location	36 5 0468688 UTM	
Parameter	Data obtained	Permissible value (FAO)
t	24	
TDS	743 mg/L	450-2000
Salinity	491	
DO^2	8.7 m/l	
pH	8.1	6.5-8.4

- The Massaca irrigation association comprises 183 ha and 230 households, each household has a plot of 0.64 ha (shown in Figure 3.4 below). The system uses gravity irrigation systems in their fields, by which water is collected from the Umbeluzi catchment and delivered to the plots. The association's membership is based on land, which has implications for the process of maintenance and operation of the system, which subsequently results in sources of contradictions as reported on in Chapter Five.

Figure 3.3: Massaca irrigation systems

- The Massaca irrigation association's managerial structure is composed of (i) a management board or irrigation committee, which includes the President, Vice-President, Secretary, accountant, and two vowels, (ii) a fiscal board, (iii) a wide-ranging assembly, which consists of all members of the association.
- The general object of the association is to (i) ensure correct use of the irrigation scheme, (ii) promote capacity and technical assistance to the associates, in order to guarantee the correct use of the system, (iii) organise the infrastructure, equipment and resources, in order to ensure continuity of the systems operation, and (iv) ensure self-sustainability of the system.
- The association applies mixed crop practices in the irrigation system, including tomatoes, potatoes, banana, maize (see Table 3.5 below). Some of the maize is produced and used for the farmers' own consumption. Most of the crops are for selling, but there are still some

farmers that practise subsistence farming in the irrigation system. The households are meant to pay water fees each month, which is used to support the running costs of the irrigation scheme. Each household crops according to its own production plan and capacities.

Table 3.5: Crops grown by the Massaca irrigation association

Local name	English	Botanical name
Amendoim	Peanuts	*Arachis hypogaea*
Milho	Maize	*Zea mays*
Mandioca	Cassava	*Manihot esculenta*
Feijao	Beans	*Phaseolus vulgaris*
Tomate	Tomato	*Lycopersicum esculentum*
Cebola	Onion	*Allium cepa*
Pimenta	Pepper	*Capsicum annuum*
Banana	Banana	*Musa paradisiaca*
Batata-doce	Sweet potatoes	*Ipomoea batatas*
Pepino	Cucumber	*Cucumis sativus*
Alho	Garlic	*Allium sativum*

As with the Macubulane irrigation association, the Massaca irrigation association members are also in transition from rain-fed agriculture to using a community-based irrigation scheme management, which also introduces a transition from subsistence to commercial farming practices. Contradictions in these transitions and the learning opportunities and demands are discussed in more depth in Chapter Five and Chapter Six.

3.2.4 The two cases

As can be seen from the above introductory descriptions, the two cases are both similar and different. Both systems are organised into Irrigation associations, namely the irrigation associations of Massaca and Macubulane. Both are in Maputo Province and it is, in both cases, the policy impetus for local irrigation associations that provides the key focus of the emergence of new forms of organisation and activity.

The cases were purposefully selected as they represent two cases where a transition from rain-fed to irrigation scheme agriculture is taking place; they differ, however, in irrigation methods and cropping practices. In both cases, associated emergent institutions and networks are present because of the newly introduced irrigation practice, management and learning processes.

Data generated in each of the cases was member checked and was examined and deepened using critical realist tools, which in the case of this research underlie and potentially strengthen the CHAT research tools and processes. In a case study-based research design, it is important to understand how things get done in a context and why. This is because different contexts impose different practices. To analyse the context, it is important to understand things such as the beliefs, assumptions, models and methods commonly held and used by group members, how individuals refer to their experiences in other groups, and what tools they found helpful in engaging the problems and processes associated with the new activity. This necessitated use of a diverse range of methods as described below in section 3.4, but these needed to be used within a conceptual framework that allows for understanding of transitioning, and development of the new activity, hence the use of cultural historical activity theory (CHAT) and expansive learning, introduced below in section 3.3.

3.3 CHAT and expansive learning (basis for Goal 1 and 2)

To develop insights into the (potentially) transformative social learning processes in the irrigation scheme development context introduced in Chapter One, and outlined further in section 3.2 above, I investigated (Chapters Four and Five) and attempted to expand (Chapter Six) transformative social learning processes. This was done by drawing on sociocultural theories of learning, as these have been identified as being growing and emphasised in current social learning theorising in the NRM context (see sections 2.1 and 2.2).

In this study, I drew particularly on Cultural Historical Activity Theory (CHAT) (after Engeström, 1987, 2001) as it provides a contextually and historically rich process-based methodology and a vocabulary to describe learning in context and for expanding learning in relation to tensions and contradictions in context (see section 2.5.5.3). Additionally, I have placed emphasis on absence, totality and transformative ethical praxis (drawn from critical realism, outlined in section 2.5.5.2) as this may provide a stronger way of theorising, enabling and monitoring transformative social learning, than theories of communicative learning and theories of transformative learning to date. The CHAT activity systems and expansive learning processes form the unit of analysis in this study, focusing on potentially or actualised transformative social learning processes.

As argued by Engeström (2001), learning-oriented research seeks insight into four central questions: (i) what learners learn (i.e. the contents and outcomes of learning); (ii) who is the subject of learning and how are they defined and located (i.e. the multiple actors involved in the learning processes); (iii) why do they learn and what makes them make an effort to learn (i.e. motives and interests); and (iv) how learning takes place and what are the key learning actions or processes of learning. As explained in Chapter Two, learning can involve expansion of knowledge, cognition, values and activity. Collective learning oriented to expanded activity is the focus of CHAT, and was of interest to this study as the focus was on community-based irrigation scheme development and management, involving community members organised in associations.

The development of activity theory and expansive learning is drawn mainly from a series of publications of Yrjo Engeström (1987, 1999a, 1999b and 2000; Engeström & Sannino, 2010) and colleagues (e.g. Daniels, 2006) who have developed this branch of sociocultural learning theory. It suits this study, as the theory has been developed in adult learning contexts and workplaces, which is similar to the irrigation scheme development contexts in this study in which adult learners are involved. This study draws on third generation CHAT; this is suitable as it emphasises the identification of and engagement with tensions and contradictions that exist between a main activity system (e.g. the irrigation farmers) and linked activity systems that influence their practice. The following sections provide a more detailed description of Activity Theory and expansive learning.

3.3.1 Cultural Historical Activity Theory – its development over time

3.3.1.1 First generation CHAT

The first generation of cultural historical activity theory was developed by Vygotsky and is centred on his concept of *mediation* (Daniels, 2008). Vygotsky developed his notion of mediation from Marx's (1876) historical concept of labour (or activity), which stated that "the simple labour processes are (i) purposeful activity, that is work itself, (ii) the object on which that work is performed, and (iii) the instruments of that work" (Marx, 1876, p. 284). This idea was conceptualised in Vygotsky's (1978) famous triangular model in which the 'conditioned mediated act' between stimulus (S) and response (R) was transcended by a complex and dynamic process-based relation that exists between subject, mediating artefact and object (p. 40) as shown in Figure 3.4 below.

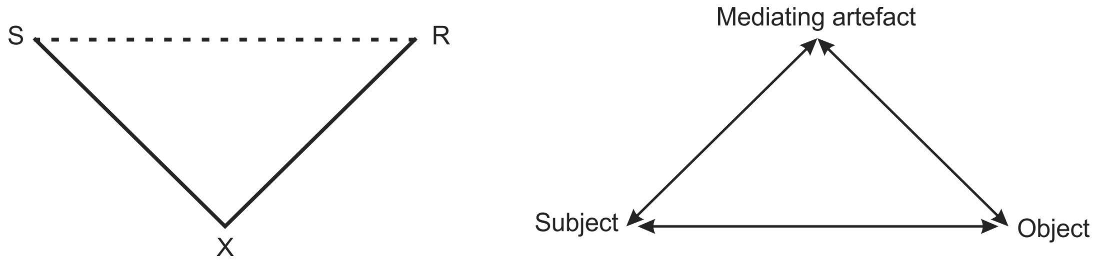

Figure 3.4: a) Vygotsky's model of mediated act, and b) its common reformulation (Daniels, 2008)

3.3.1.2 Second generation CHAT

Second generation CHAT was developed by Engeström (2001). It draws on the work of Leont'ev (1978). At the time, including cultural artefacts as part of human actions as the basic unit of analysis was innovative. Engeström (2001) advocated the need to consider the study of tools and artefacts as "integral and inseparable to human functioning" and he argued that the focus of the study of mediation should be on its relationship with mediated collective activity. This gave impetus to Engeström's more developed analysis of the activity system surrounding collective activity, which included giving attention to rules, community, and division of labour, as these influence and mediate activity, as outlined in Figure 3.5 below.

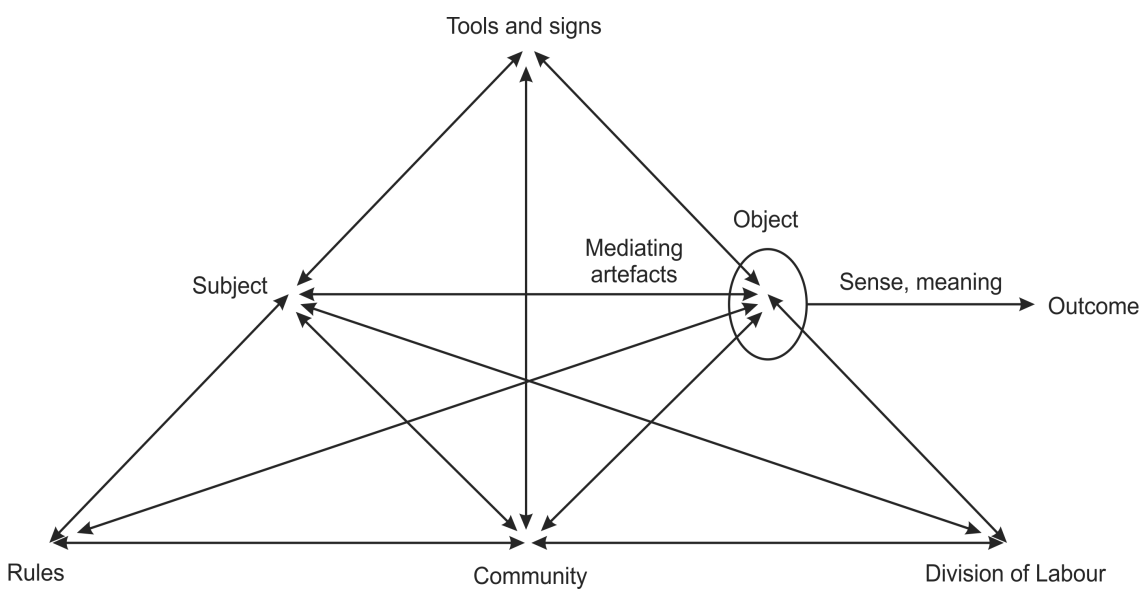

Figure 3.5: Structure of the human activity system (Engeström, 1987, p. 78)

However, the schematic triangle depicted in Figure 3.5 is only the *tip of the iceberg,* representing individual and group actions embedded in a collective activity system. Of importance to this study, is that each of the elements highlighted in the figure have complex sociocultural histories, and that there are dynamic interactions occurring all the time between various elements of the activity system (Engeström, 1987). Therefore, the activity system needs to be interpreted as a dynamic system with ongoing potential for change and transformation as tensions and contradictions emerge and are resolved (or not). In Figure 3.5, the object is depicted with the help of an oval, indicating that object-oriented actions are always, explicitly or implicitly, characterised by ambiguity, surprise, interpretation, sense making, and potential change; this is significant for the transformative social learning interest of this study. According to Daniels (2008), the conceptualisation of the activity system took the sociocultural learning theory paradigm a huge step forward, since it turned the focus onto complex interrelations between the individual subject and his or her community, the rules and structures of that community for organising division of labour, as well as the mediating tools that are used in the activity system to mediate object oriented activity (e.g. irrigation farming). However, when activity theory was critically debated internationally, questions of diversity and dialogue between different traditions and interacting activity systems became an increasingly serious challenge to the theory. This led to the development of third generation CHAT (Engeström, 1987, 2001; Daniels, 2008).

Despite the critiques of second generation activity theory, there are some aspects of second generation activity theory that are relevant to this study, most importantly its emphasis on multi-voicedness of activity systems and an understanding of the way that individual actors bring in their own histories from the social positions that they take up in the division of labour within the activity. In the context of this research, this required that I develop a clear perspective of multi-voicedness in the farmers' irrigation activity systems in the two cases. Of further significance to this research is the way in which second generation activity theory, following the Vygotskian 'generic' tradition, engaged with an historical development analysis of activity. As a result, tensions and contradictions are identified, as these have been noted to be powerful sources of change and development if engaged with proactively. In relation to this, Engeström (1999b) viewed the construction and redefinition of the object as related to the "creative potential" of activity, highlighting the transformative potential in collective activity (p.381). Using Engeström's second generation activity theory, I developed insights into different, interrelated activity systems (AS) relevant to the irrigation scheme development context, e.g. (i) irrigation of crops AS, (ii) marketing AS, and (iii) management AS; I took account of the fact that these systems may differ in the two sites (see Chapters Four and Five). This was done to gain insight into existing learning practices and also to identify potential contradictions, absences and tensions, which may be used to stimulate further learning. This analysis was strengthened by consideration of the generative mechanisms and structures that shape and influence experiences and events in these activity systems, which critical realism requires (Bhaskar's 1M and 2E; see section 2.5.5). Mukute's (2010) study showed that this allows for a more rigorous understanding of the contradictions and tensions in the activity systems and how they are generated.

Further developing the transformative dynamics of CHAT, Engeström (1987, 1999a) maintained that it is important to extend beyond the singular activity system and to examine and work towards transformation of networks of activity. To this end, he saw potential in the exploration by some theorists of the concept of 'boundary object', 'translation', and 'boundary crossing' "to analyse the unfolding of object-oriented cooperative activity of several actors, focusing on tools and means of construction of boundary objects in concrete work process" (p 7).

3.3.1.3 Third generation CHAT

Third generation activity theory, outlined in Engeström (2001), takes joint activity or practice as the unit of analysis, rather than individual activity, as depicted in Figure 3.6 below. In this context, Engeström (2001) argued that analysis is concerned with processes of social transformation and incorporates the structure of social work, with particular emphasis on the conflictual nature of social practice, thus recognising the need for 'dissonance', as outlined in theories of transformative social learning in section 2.4. Instability and contradictions are regarded as "the motive force of change and development" and the transitions and reorganisation within and between activity systems as part of evolution of activity (Engeström, 1999a, p. 63). Engeström did not engage with the notion of 'absence' within the Bhaskarian dialectical framework, noted in Chapter Two, section 2.5 which I see as a possible way of strengthening third generation CHAT and theories of transformative social learning as noted above. Third generation of activity theory aims to develop conceptual tools to understand dialogues, multiple perspectives, and networks of interacting activity systems.

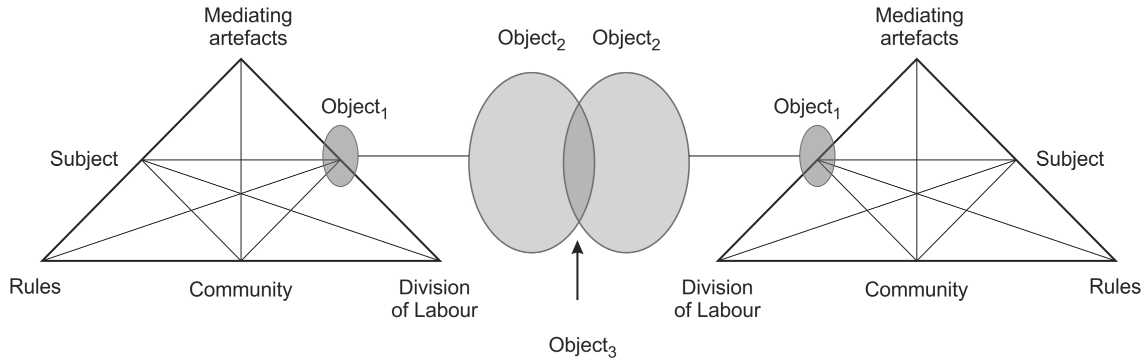

Figure 3.6: Two integrating activity systems as a minimal model for third generation activity theory (Engeström, 2001)

Third generation activity theory endorses that all activity systems, in their totality, constitute human society. It also recognises the dynamic interrelationships that exist between different activity systems within this 'totality'. Empirically, it would be impossible to study all these activity systems, but it is possible to study some of the interactions that occur between activity systems at a local level (surrounding the primary case activity system). However, these can be considered within the idea of 'totality' (Bhaskar's 3L) to gain a broader perspective on how these activity systems interrelate and are, in turn, influenced by other activity systems.

Third generation CHAT can be summarised with the help of five principles provided by Engeström (2001) and Engeström and Sannino (2010): (i) a collective, artefact-mediated activity system, seen in its network relations to other activity systems, is the prime unit of analysis; (ii) an activity system is always a nexus of multiple viewpoints, traditions and interests; the division of labour in an activity creates histories and the activity system itself carries multiple layers; (iii) the activity systems take shape and get transformed over lengthy periods of time (but this can be 'fast tracked' through purposeful engagements in expansive learning interactions); (iv) contradictions play a central role as sources of change and development in activity systems; contradictions are not the same as problems or conflicts; contradictions are historically accumulating structural tensions within an activity system, which are shaped by generative mechanisms (Mukute, 2010); and (v) the possibility of expansive transformation always exists in activity systems.

Expansive learning deals with boundary crossing, as shown in Figure 3.6 above. Engeström (2005, 2008a) indicated that boundary crossing is the result of humans being involved in many activities and being part of collective activity systems. Engaging with issues associated with the common object provides tools for double stimulation and requires negotiation and re-orchestration resulting in and involving collective concept formation across boundaries.

Significant to this study, is that third generation activity theory, as outlined in Engeström (1987, 2001) takes joint activity or practice as the unit of analysis for activity theory, rather than individual activity. It is here that the possibilities for examining and expanding transformative social learning processes across boundaries of existing activity systems exist. This study's concern with the third generation of CHAT lies with the emphasis on collective activity assuming changes/transformation as a result of social interaction/participation and learning in irrigation management. Through identification of contradictions that arise in these practices, and absences, and through negotiation and implementation of 'model solutions', a reflexive process can be produced through systematic analysis of these contradictions in Developmental Work Research (DWR) workshops and in practice contexts (also known as Change Laboratory Workshops) (Engeström, 2007). Such an analysis will address Goal One of the present research, and also incorporates elements of Goal Two.

Later, Engeström (2001) worked on methodologies and approaches to expand learning in activity systems through, for example, his proposal to use Change Laboratory workshops to mirror data and model solutions, captured as an important part of an expansive learning cycle (see section 3.3.2 below).

3.3.2 Expansive learning as a form of interventionist research

Engeström (1987) introduced activity system analysis to map the co-evolutionary interaction between individuals or groups of individuals and the environment and how they affect one another. It extends mediated action as a model of human activity that accounts for socio-political situations (Cole, 1996), and socio-material / social ecological elements (Fenwick, 2006; Mukute, 2010). As noted in the previous section, the unit of analysis in activity system analysis is the object-oriented activity itself and the system dynamics that shape it (Engeström, 1987, 1999b, 2001). In the case of this study, the examination of individual farmers' engagement in the irrigation scheme development activity system provides an entry point for examining participants' activity and learning (Yamagata-Lynch, 2003) and for expanding the activity in interactions with them via formative interventionist research approaches (e.g. using the Change Laboratory Workshop approach used in DWR – see below). Through examination of these activities and learning within the frame of third generation activity theory, as described in the previous section, it becomes possible to examine the collective meaning making process (Yamagata-Lynch, 2003), and expansion of learning and activity in potentially transformative ways which is the subject of this research.

One could say that expansive learning is a form of transformative social learning, except that the ‘absenting of absences’ and the relation to ‘ethical directions’ of the transformative praxis are not as explicit in Engeström’s work as in Bhaskar’s’ 4D. However, Engeström did have a commitment to transformation (at the level of changed activity), as he claimed that expansive learning and enhanced professional practice occurs in activity settings, which enable explication of the object of activity: “Expansive learning involves the creation of new knowledge and new practices for a newly emerging activity” (Daniels, 2008, p. 126). This brings me to my earlier points that it is the transformations in the farming activity system practices that will also provide evidence of transformative social learning (from the rain-fed agriculture practices to sustainable irrigation scheme agricultural practices). Changes in practice within the wider activity would be an indication of qualitative transformation of the entire farming activity system. Such transformation may occur by introduction of new knowledge or a set of regulations, but, as shown in the discussions on transformative social learning in research outlined in Chapter Two, cannot be reduced to these ‘singular acts’. According to Engeström, expansive learning can be mediated and it can follow a process that is represented in Figure 3.7 below.

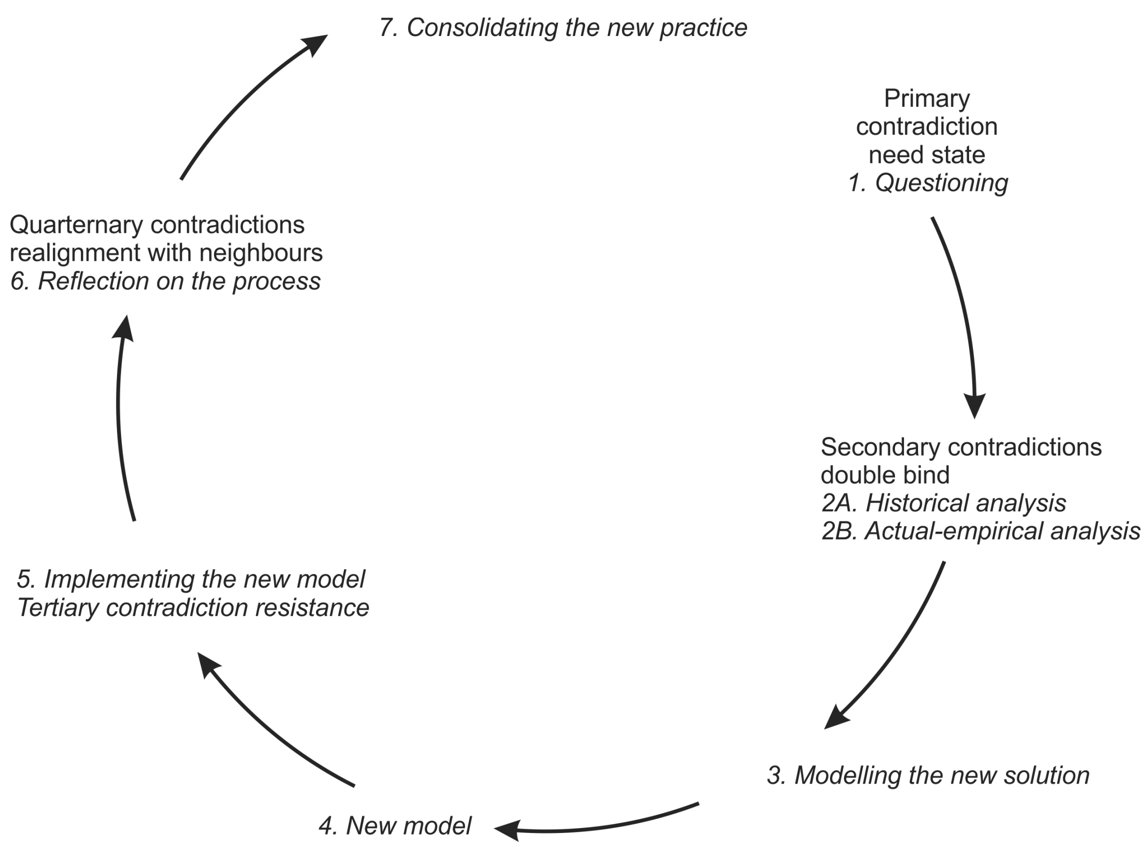

Figure 3.7: Expansive learning cycle, with learning actions 1–7 outlined (Source: Engeström, 2001)

Figure 3.7 above represents strategic learning actions and corresponding contradictions in the cycle of expansive learning that will be considered in this research context to inform active engagement with and support for transformative learning in Phase 2 of the research, which will address Goal Two.

The expansive cycle begins with individual subjects questioning the accepted practice, and it gradually expands into collective movement or institution. In expansive learning, what drives appropriation, and thus development, is the contradictions and tensions between individuals and sociocultural influences, between two or more elements of an activity system, and between different activity systems. To develop means to resolve or transform these contradictions (instead of merely shifting them elsewhere), and it is this that will result in a change in the activity system involving the construction of new objects and motives (Engeström & Sannino, 2010). Such change is a long-term cyclical and spiral process of internalisation and externalisation, which Engeström (1987) called *learning by expanding*:

> The essence of learning activity is production of objectively, societally new activity structures (including new object, instruments etc.) out of actions manifesting the inner contradictions of the preceding form of the activity in question. Learning activity is mastery of expansion from actions to a new activity. (p. 125)

In Change Laboratory formative interventions, such dialogical and longitudinal relationships form the foundations for practical, material generalisation of novel solutions and developmental breakthroughs. These solutions are articulated with the help of new concepts and models, which become findings that can acquire significant theoretical importance and turn those concepts and models into tools (Engeström, 2007).

Important though is a clear understanding of the nature of expansive learning research conducted using approaches such as change laboratories as being *formative interventionist research*. As explained by Virkunnen and Newnham (2013, p. xvii): "In this framework, the end results of learning are not predetermined by the interventionists or researchers. The outcomes are designed by the participants as they work out expansive solutions to developmental contradictions in their activity systems". This places a particular responsibility on the formative interventionist researcher which I discuss later in this chapter in the section on ethics (see section 3.10). Data generation is therefore not extractivist, but is used as a means of informing formative interventionist engagements that serve to support multiple actors engaged in the activity to transform their activity; i.e. the research is in the service of the process of activity transformation, and not only about this process of transformation.

3.4 Data collection

The following data collection methods, listed in Table 3.6 below, were used to generate data for all of the research goals within the case study and CHAT research frameworks outlined above. The use of each tool and the type of data it generated is briefly discussed in this section.

Table 3.6: Methods and analysis

Goals	Methods	Analytical framework	Comments
I	Document analysis; interviews (with key stakeholders in relevant activity systems) and focus groups with farmers and other key stakeholder groups; video monitoring of Change Laboratory workshops; observation	CHAT Analysis (second and third generation AS analysis; with emphasis on the latter); identification of tensions, contradictions and absences	Using third generation activity theory
II		Change Laboratory workshops within the expansive learning cycle (Engeström, 2007)	Workshop development
III		Muro and Jeffrey (2008) model; Wals (2007); Engeström (2007) and critical realist dialectical perspectives on transformative learning (Bhaskar, 1993)	Develop a tool to analyse transformative social learning that is inclusive of individual, collective and societal transformation aspects
IV		Critical Realist dialectical perspectives on transformative learning (Bhaskar, 1993; Norrie, 2010)	Develop tools to identify further potential for transformative social learning

3.4.1 Document analysis

Relevant documents in the context of this research were collected and analysed. Documents for analysis included administrative documents, formal studies, organisational records, maps, and survey data. These sources provided data and information on the history of the communities; the progress being made with the irrigation scheme development; relevant policies and reports. Documents that are used in the mediation of introducing and supporting the irrigation scheme development were also analysed for their role and influence in the activity systems and for the insights that they provide into the activity systems and their construction. As stated by Bowen (2009), document analysis allows for generating historical perspectives. It also allows the researcher to obtain empirical data that extends and complements interviews and observations, enhancing the credibility of the research. Table 3.7 below shows the documents used for analysis in this study.

Table 3.7: Documents gathered for analysis

- Joint study of Umbeluzi River basin, SWECO
- GoM Joint Water Resources Development Study of Maputo, Umbeluzi and Incomati River Basins, April 2004
- Ministry of Public Works of Mozambique Embassy of the Kingdom of the Netherlands Mission of Technical Assistance for Flood Recovery in Mozambique, 2 April 2013
- GoM First National Water Development Project, National Water Resources Development, Plan for Incomati River Basin, January 2003
- GoM First National Water Development Project, National Water Resources Development, Plan for Umbeluzi River Basin, December 2003
- Technical Permanent Committee Tripartite (TPCTC) between Mozambique, South Africa and Swaziland, 2010. Report on Alternatives of Water Management and Viability, Part B: The Incomati basin, April 2011, by Aurecon
- GoM Ministerial Diploma n 91/2008, 28 April, Internal Regulation of Ministry of Agriculture
- GoM, Macubulane Peasant Association, III SÉRIE-Number 19
- GoM Resolution n 2/2013 Organic Status of National Irrigation Institute
- GoM, Decree n 9/2012 Establishment of National Irrigation Institute
- Ministry of Agriculture, Irrigation Strategy 2011
- GoM III SERIE-Number 34 Massaca Irrigation Association Status
- Ministry of Education and Culture, Curriculum: Complementary year of Technical – Professional teaching, 2008
- PIREP. Information for Qualification Registration for Vocational Certificate on Agro-Livestock field of Agriculture and Nature Conservation
- PIREP. Information for Qualification Registration for Vocational Certificate on Agriculture and Livestock field of Agriculture and Nature Conservation QAGRO014001
- Vocational Certificate on Agriculture and Livestock field of Agriculture and Nature Conservation, Manual of the module for the teacher MO AGRO13010, operate and basic maintenance of irrigation and drainage system
- Curriculum on Agriculture and Rural World, course of Rural Agent

3.4.2 Interviews: Semi-structured interview and focus groups

In a case study approach, interviews are an important source of information and they often take the form of guided conversations rather than structured enquiries (Yin, 2003.) Although a researcher may pursue a consistent line of inquiry, the actual stream of questions is likely to be fluid rather than rigid

(Rubin & Rubin, 1995). As a result, case study interviews are often open-ended in nature, and the researcher can ask key respondents about the facts of the matter as well as their opinions and insights about certain events (Yin, 2003). This research drew on insights and opinions generated in interviews as a basis for further lines of inquiry (ibid).

A semi-structured interview format was used in each case study, as this allows for open-ended questions and flexibility. Individual interviews were conducted with farmers of the Macubulane and Massaca irrigation associations and conversations took at least one hour each. The farmers were enthusiastic to be interviewed because they thought that it would help them to improve activities and it was an opportunity for them to present what they knew. The semi-structured interviews were guided by a list of questions or issues to explore the irrigation scheme activity systems and practices and their histories and current forms. The questions also focussed on issues of management, as well as the identification of tensions, contradictions and absences. Other aspects, such as roles and responsibilities, divisions of labour, and other views of respondents, were further probed in detail, in such a way that accommodated emerging new ideas on the topic. This allowed me to gather information and data for further workshops.

At each site, two to six farmers were interviewed, one extension officer, one member of the irrigation management board, and one irrigation maintenance person. I interviewed six farmers in each case context (depending on the practices). These identified respondents were considered to have potential agency in the activity system.

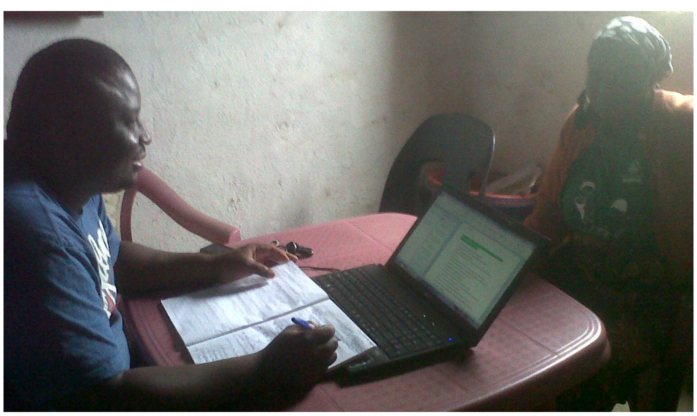

Figure 3.8: Interview with Macubulane irrigation association member

In addition to semi-structured interviews, I also used focus groups to generate data. A focus group involves interviewing a group of people that have knowledge of a topic (Krueger & Casey, 2008; Merriam, 2009). Focus group interaction in each research site allowed me to probe what participants, especially the farmers, understood about issues, knowledge and practices in the context of irrigation system management.

Figure 3.9: Participants in one of the focus groups, Macubulane irrigation association

Focus group interviews were conducted with farmers, the management board, and extension officers. All interviews were recorded using audio recording tools. The exact focus groups were defined in the context of each research site. The individual interviews and focus group interviews provided additional data for use in the Change Laboratory workshop, as described in the following section. Detail of the questions used to guide inquiry during the interviews, focus groups and change laboratory workshops is included in Table 3.8 and Table 3.9.

Table 3.8: Inquiry guiding contextual profiling, activity system, Change Laboratory workshops

A. Contextual profile

Inquiry in socio-ecological system of irrigation association

- What are the resources in irrigation association?
- Who are the users of those resources?
- How is the irrigation association composed, who are the partners?
- Who is responsible for operation and management?
- What rules do you use for irrigation?
- Who monitors activities in the association?
- Do you face issues such as floods, soil erosion?
- What were things like before the establishment of irrigation association?
- How did practices change after the development of irrigation association?
- What have you learned from the irrigation association?
- How do they manage water, soil, fertilizer, how sustainable is it?
- How do they manage the crops?
- What is the productivity like?
- What do they do with the products?
- What knowledge is there in terms of commerce?
- What is quality of the products?
- Who did you learn irrigation practices from?
- What courses have been developed (capacity building programmes)?
- How do you operate the association, what are the challenges, what has been done to face these?
- Is conflict resolution necessary (land, water, and forestry)?
- How do individuals operate in social learning context and learning interactions?
- Geo-physical profiling of hydrology features, climate, water quality, biology, crops soil conditions

B. Questions on analysis of activity system

B.1 Activity system tools

The table below presents the activity system framework from which questions for data collection and analysis were extracted.

Components of activity system	**Explanation**
Subject	Group of individuals whose intervention is considered in analysis of activities with the object of the system. The relation with subject is mediated by the tools, rules community and division of labour
Object	Concerns that are being worked on
Output	Expected result of the object
Tools/Artefacts	Conceptual artifacts and tools to understand or transform the object (culture, capacity, knowledge involved in the development)
Division of labour	Vertical or horizontal allocation of labour that facilitates the relation between community and object
Rules	Interaction and mediation between subject community, including the subject and the object
Community	Individuals and collectives working together with the irrigation associations

B2: Setting questions for analysis of the context for learning based on the tools above

Context is internal to people (involving specific goals) and external (involving artifacts, other people and setting). In addition, include the location, technology and environment context concerning the irrigation system and management.

Questions include:

- How do things get done in this process?
- Why?
- Who is doing what and why?

In the design/setting/description it is important to know how things get done in a certain context and why. Consider that different contexts imply different practices. To analyse the context, one needs to know the beliefs, assumptions, models and methods commonly held by group members, how individuals refer to their experiences in the group, what tools they found helpful in completing their activities, and also consider external-driven context. These include issues highlighted by Roher-Murphy and Jonassen (1999)

a) What type of limitation is placed on the activity by outside agencies?
b) How are the tasks organised among the members of the working group towards the object?
c) What is the structure of social interaction surrounding this activity?
d) What activities considered to be critical?
e) How flexible is division of labour, laws or assignments that guide the activities?
f) Is there a difference between implied rules and those formally stated?

Clarify relevant context within which activities occur

Questions

g) What are the activities, goals and sub goals to be supported by the learning environment?
h) Who are the users/members involved?
i) Where does the problem occur?
j) What is purpose of the activity/action for users?
k) What is the user trying to achieve?
l) What are the expectations/ outcomes?
m) What are the beliefs, assumptions, models and methods commonly held by the working groups?
n) What tools do users find helpful in completing these project, in different contexts?

Framework for analysis of the activity system adapted from Lorna (2007)

- Who are the people involved in this activity system? What are their roles?
- What is the outcome of the activity?
- What are the criteria for evaluating farming activity?
- What are the rules (implied formal) of the members of the group of learners?
- What is the division of labour within the activity system?
- How is the work being done in practice in the irrigation association?
- How is work (actions and operation) transformed over time?
- What historical phases have there been?
- What are the goals/motives of the activity and how are they related to other concurrent goals?
- For each activity, what action can be performed and by whom?
- For each action, observe and analyse the operation that the subjects perform.
- What are the basic limitations of the current technology?
- Are there conflicts between different goals?

Criteria for the successes or failure of achievement goals

Framework for analysis of contradiction may include these issues:

- What are the dynamics that exist between the components of the activity system?
- Are there contradictions or disturbances between the needs of various components of the activity?
- What interrelations exist within the components of the system?
- How have these relationships changed over time?

Potential primary contradiction in the irrigation systems

Primary contradiction may happen at node level of activity system e.g.:

- Object node
- Rule node
- Division of labor
- Tools node

Potential secondary contradiction in irrigation system

Happens between nodes in the activity system e.g.:

- between rules and division of labour in the activity system, tension may occur due to unclear rules or regulations that determine the role of each actor involved
- diversity of perceptions with regard to the object of activity system
- tension between community (society) and the object node (learning). Learners may not be interested in very high productivity

Potential tertiary contradiction

- Tertiary contradictions may be found when an activity is remodeled to take account of new motives or ways of working. Thus they occur between an existing activity and what is described as a more advanced form of that activity.

Potential quaternary contradiction.

- Quaternary contradictions occur between different co-existing or concurrent activities and can be perceived as a complex and continuing evolving web of contradictions that emerge. Primary and secondary contradictions in an activity may give rise to a new activity which in turn spawns a set of tertiary contradictions between it and the original activity and this may be compounded by quaternary contradictions with co-existing activities

B3: Workplace learning day by day activities

- When you come to association what do you do each day?
- What are the learning challenge?

C: Change laboratory workshop

- What is the activity system?
- What are the components of an irrigation association?
- What is the object of activity in an irrigation association?
- What is community based irrigation management?
- What are the learning barriers?
- What do you understand by sustainability?
- What is irrigation efficiency?
- How do you understand sustainable irrigation?
- What are the irrigation practices?
- Who is shaping or influencing the farmers' learning and how?
- What are the learning perceptions on irrigation association management?
- What learning practices are in place in the irrigation association?
- What are the learning changes in the irrigation association?
- What are learning management practices in place?
- Are there sustainable management practices?
- Are there sustainable learning practices?
- How do you deal with environmental risks?
- Who are the main partners?

Table 3.9: Inquiry guiding the feedback workshop

Feedback workshop
• What are the current activities of the association and management board? • What knowledge do you use here? • How do you solve the problems? What are the conflicts that constrain members and others? • Is what you have learned relevant for you during the period of this research? • Do you feel that the association is doing well, why? • What are the pending issues? Why and what are the needs? • If members do not earn enough, what are they doing to change this situation? • How do you understand irrigation management and irrigation system? • Do you meet with members, when, why and what is the learning? • Do you have an environmental management plan? • Why are there prayers before starting activities? • What are the beliefs? • Do you think that in future, things will move forward - why? • Is there cross boundary learning? • How do they use the equipment and what is the importance of having this equipment? • What is the importance of the course and workshops including change laboratory workshops? • What is the way forward?

3.4.3 Change laboratory workshops

To address research Goal Two, Change Laboratory workshops were organised to stimulate transformative social learning processes. In this research, I engaged with the following Change Laboratory workshops which are based on findings derived from the first research phase:

- Workshop 1: Orientation workshop (key concept)
- Workshop 2: Questioning and identification of contradictions, tensions and/or absences
- Workshop 3: Analysing the contradictions, tensions and/or absences for potential 'model solution' development
- Workshop 4: Modelling the new solutions
- Workshop 5: Follow up workshop to establish how the learning trajectory has progressed, focusing on reflections on the modelled solutions and aspects of their implementation.

Mukute (2010) and Masara (2010) have both shown that while the expansive learning process is easy to achieve up to the level of model solution building, it may take time for the solution to be implemented. Thus, a reflection after a period of time is a necessary follow-up. Mukute (2010) showed in his study that useful reflective information can be obtained some six months after the fourth workshop, which was possible within the scope of the study's duration.

Engeström (2001) used Developmental Work Research (DWR) as an approach to facilitate expansive learning. The methodology and learning actions associated with DWR are outlined in Figure 3.7 above. I used the same approach for Goal Two, which can also be Phase Two of the research process. The DWR is a process-based method to mirror or share and discuss identified contradictions, and identifies potential solutions between activity systems through a participatory approach. Change Laboratory workshops follow a cycle that may include:

- drawing on ethnographic evidence to question existing practices;
- analysing of historical origins of existing practices, and bringing these analyses to bear in the analysis of current dynamics within and across services;
- modelling an alternative way of working – this means development of a new model of learning;
- examining the model to understand its dynamic, strengths and pitfalls;
- implementing the model and monitoring the process and impact to implementation in the dispositions and actions of professionals; and
- drawing on these data to reflect on the process and outcomes (Engeström, 2001).

In both the semi-structured and focus group interviews I probed what was there, what was being done, how things were being done, how people were learning the new practices, what complexities and tensions were being experienced, as well as what was not there, and what may not be happening (yet could be happening). Interview and focus group data was used to inform change laboratory workshops, and also for following up. Change Laboratories generated additional qualitative data which was captured using audio and video recordings as I was engaged in the workshops as facilitator, or intervention researcher.

Interviews and the Change Laboratory workshops were the most important sources of data in this research. Tables 3.10 and 3.11 present the interviews and Change Laboratory workshops that were conducted at both sites.

Table 3.10: Overview of interviews and Change Laboratory workshops at Macubulane

Macubulane data	Event	Participants	Goals
1 February 2011	Focus group with association management committee	Appendix Ai	Workshop 1: Introduction orientation workshop (key concept contradiction)
4 June 2012	Individual interviews	Farmers, see Appendix Aii	Workshop 2: In depth interviews to access activities and practices, individual stories in irrigation association
13 February 2013	Focus group	Association management committee, farmers, Incomati Company, see Appendix Aiii for list of participants	Workshop 3: questioning and identification of contradictions, tensions and/or absences
9 May 2013	Change Laboratory workshop	See Appendix Aiv for list of participants	Workshop 4: Analyse the contradictions, tensions and/or absences for potential 'model solution' development
10 May 2013	Change Laboratory workshop	See Appendix Aiv	Workshop 4: Modelling the new solutions
26 October 2013 & 15 March 2014	Feedback workshop	See Appendix Av	Workshop 5, 6: Follow-up workshops to establish how the learning trajectory has progressed; focused on reflections on the modelled solutions and aspects of their implementation

Table 3.11: Overview of interviews and Change Laboratory workshops in Massaca

Massaca data	Event	Participants	Goals
14 February 2013	Focus group with association management committee; meeting with association board	See Appendix Avi	Workshop 1: Introduction orientation workshop (key concept contradiction)
9 June 2013	Individual interviews	See Appendix Avii	Workshop 2: In-depth interviews to access activities and practices, individual stories in irrigation association
7 February 2013	Focus group with association management committee, farmers, CIDAE, Agrarian Institute	See Appendix Aviii	Workshop 3: Questioning and identification of contradictions, tensions and/or absences
2 May 2013	Change laboratory workshop	See Appendix Aix	Workshop 4: Analysis of the contradictions, tensions and/or absences for potential 'model solution' development
3 May 2013	Change laboratory workshop	See Appendix Aix	Workshop 4: Modelling the new solutions
28 October 2013 March 2014	Feedback workshop	See Appendix Ax	Workshop 5 and 6: Follow-up workshop to establish how the learning trajectory has progressed; focusing on reflections on the modelled solutions and aspects of their implementation

Figure 3.10: Change Laboratory workshop with Massaca irrigation association

3.4.4 Observation

Observations were made during visits to the research site, where environmental conditions were available for observation. These observations become an essential source of evidence in the case study analysis. This included observation of meetings, workplace activities, and conditions of physical irrigation system.

Observations took place in naturalistic contexts at workplaces in the two irrigation scheme sites, as well as at the associated management offices and adjacent area (see Figure 3.11). This was to develop an understanding of the farmers' practices and activities, patterns of interactions and conditions. Observations facilitated the collection of both qualitative data (for example, how farmers were engaging with the irrigation scheme activities) and quantitative data (for example, data on how many farmers were involved in the irrigation scheme management, or how much water was available for crop production).

Figure 3.11: Crop production observed in field of Massaca irrigation association

Figure 3.12: Example of an observable contradiction in Massaca irrigation association: A defect in maintenance of irrigation system

During the observation process, I used camera photography and video photography where relevant (e.g. to capture some of the irrigation scheme practices or technologies and how they work). See, for example, Figures 3.11, 3.12, 3.13 and 3.14. These observation technologies helped me to capture what was happening in the field so that this could be used for further reflection as outlined in Table 3.12 below.

Table 3.12: Observation methods used

Category	Examples of objects and processes observed
The physical setting	The environment and conditions of irrigation system, the infrastructure and method of irrigation system; what objects, resources, technologies and processes existed in the setting; what was absent from the setting; the physical attributes of the office and irrigation system (and absences).
The participants	Description of who was present, how many people, and their roles; what was the division of labour in the activity system; the kind of behaviour; who was not present and who may need to be present (e.g. extension officers may be needed in the setting, but may be also be absent); what brought those people together; who was allowed where; what were the characteristic of the participants; patterns and frequency of interactions; the direction of communication patterns.
Activities and interaction	Any definable sequence of activities; how people interacted with the activity and with one another; how people and activities were connected; what norms or rules structure the activities and interactions; what mediating tools and artefacts were present in the setting, and what may have been absent (e.g. mediating materials in vernacular language); when did activities begin; how long did they last; whether the activities were typical or unusual; what activities might have been missing.
Conversation	The content of conversations; who spoke to whom; who listened; the dynamics of the interactions; direct quotes, paraphrase, and summaries of conversations. Such conversation analyses are particularly important for the Change Laboratory workshops (Mukute, 2010).
Subtle factors	Informal and unplanned activities; missing elements; symbolic and connotative meanings of words and actions; non-verbal communication; unobtrusive measures; and what did not happen that could potentially happen.

Figure 3.13: Observing learning activities among farmers

Figure 3.14: Observing activities in the field (extensionist monitoring activities in Massaca irrigation association)

3.5 Analytical framework for Goal Three

The previous section described data collection methods used and type of data collected; in this section I describe the analytical tools used to access and interpret (transformative) social learning in irrigation associations.

3.5.1 Social learning analytical tools

To develop the analytical framework for interpreting and identifying evidence of transformative social learning, this research drew on insights into transformative social learning, as provided by Muro and Jeffrey (2008) (see Chapter Two, section 2.2.1 for a detailed description). These insights were expanded and developed through additional perspectives on transformative social learning as found in the literature, as discussed in Chapter Two, sections 2.4 and 2.5

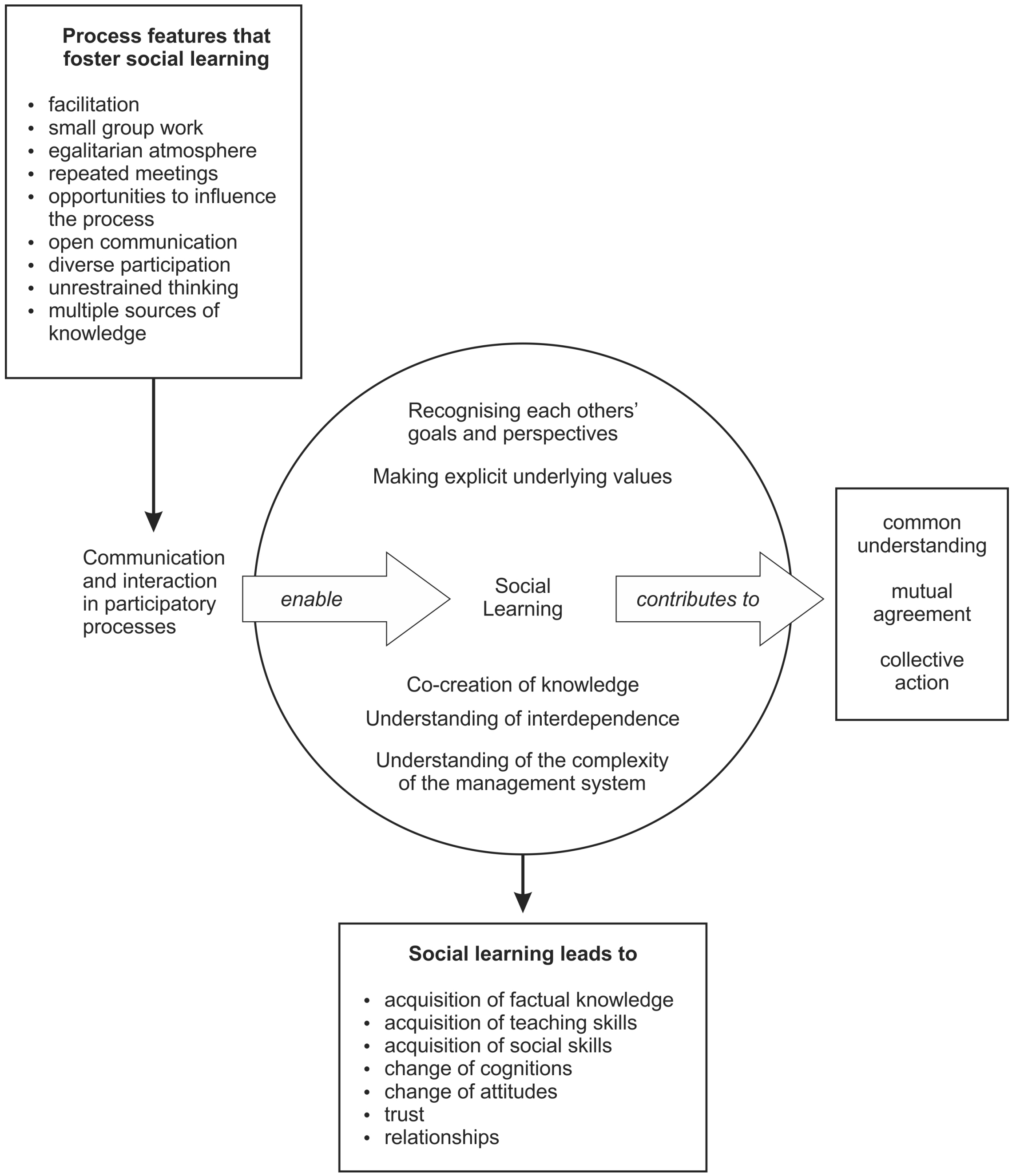

Figure 3.15: Social learning model (Muro & Jeffrey, 2008)

As indicated in the discussion in Chapter Two, sections 2.2 and 2.3, on current conceptualisations of transformative social learning, the model in Figure 3.15 analyses communicative aspects of transformative social learning. However, the model does not take full account of other ways of theorising or analysing transformative social learning. For example, it may be possible to add a tool to this framework to analyse transformation in practice (e.g. better management practices). I developed a refined analysis tool based on a critical review of the social learning literature (Chapter Two).

3.5.2 Inductive and abductive inferences

Inductive inference means that a valid conclusion can be drawn about a wider population (in this case this will be limited to the case contexts) or phenomenon (in this case this will be focused on understanding aspects of transformative social learning) from a number of observations (Danermark et al., 2002). To undertake this analysis, I used data triangulation. I used this approach to construct Chapters Four, Five and Six, by using data from the interviews, focus groups, change laboratories and observations. The aim of triangulation is to validate the data.

Abductive inference entails the interpretation and recontextualisation of individual phenomena within a conceptual framework or set of ideas (Danermark et al., 2002). This allows the researcher to understand some thinking or evidence in a new way by observing and interpreting this phenomenon within a new conceptual framework. This research sought to re-interpret evidence of learning as transformative social learning, drawing on the theoretical tools provided by authors such as Wals (2007) and Muro and Jeffrey (2008) and by critical realist concepts of absence and transformative praxis, among others, which I captured in the revised analytical model for reviewing transformative social learning outlined and discussed further in Chapter Seven. This provides guidance for the interpretative process by which meaning is ascribed to events in relation to a larger context (Danermark et al., 2002). This approach is employed in Chapters Six and Seven.

3.5.3 Critical realism as analytical tools

In the previous chapter I provided an intellectual argument for the inclusion of critical realism as an underlabouring philosophy for this study. In this section I highlight mainly those aspects of critical realism that were used analytically in the study.

As argued in Chapter Two, critical realism was also important for analysis, and I was particularly interested in using dialectical critical realist analytical tools to identify further potential for transformative learning to address Goal 3 of the research (Norrie, 2010). This involved analyses of:

- 1M: Being (what is real, actual, what is happening). Critical realist ontology and observations of the activity systems and how they function, and what is or has been learned in the transformations of practice towards irrigation scheme implementation (this is essentially the data generated for Goal 1 and 2).

- 2E: Absence (what is not there, contradiction) (becoming). This involves working with the identified contradictions and tensions, as well as insights into what is not there (absences) to identify what could be (Goal 2 and 3).
- 3L: Totality (how are the practices related to a broader understanding, what would be there for real). This involves interpreting the above in the relation to possibilities, such as successful agricultural irrigation schemes; full participation of stakeholders; no tensions, contradictions or absences; fully sustainable practices (where economy, society and ecology are in balance).
- 4D: Praxis (what are the possibilities and capacity for practical human agency to change, to transform, what could happen, what has happened). And how can this be ethically constituted in relation to sustainability, democracy and other norms that are valued in transformative social learning processes and in the contexts concerned.

This final analysis is presented as a 'meta-analysis' in Chapter Seven, that seeks to add insights into how the research and learning can be taken forward. It should be noted here that the identification of what is, and what absences may be identified are also important in the context of Goal 1 and 2 (Phase 1 and 2) of the research, and I while this is identified as Goal 3, it was also integrated into other phases of the research.

Sobh (2006) argued that the realist paradigm is a growing movement transforming the way insights in research are formed, as it avoids methodological individualism, the epistemic fallacy, and ontological monovalence. Methodological individualism occurs when researchers explain social and economic causality by reference to the actions of individuals; the epistemic fallacy occurs when researchers accept that what is said by someone is a real reflection of what is, while ontological monovalence is the assumption of a purely positive way of being. The desire of realist researchers is to provide explanations that take account of the real, the actual and the empirical in ways that are not conflated, and through this, to develop explanations that cover "… several contingent contexts and different reflexive participants" (Pawson & Tilley, 1997, p. 152).

Bhaskar (1998) argued that social scientists can study both ideas and what those ideas are about. For instance, the study of a particular society at a particular time will include information about the class structures of that society at that time, and also about the ideas prevalent in that society, which will include ideas about its class structures. It may be that many people in that society believe that it is a classless society, when in fact is not (ibid.). In the case of my study, this required me to analyse what was said about irrigation schemes (the ideas) and what was actually happening in the irrigation associations involved in the schemes. These were not necessarily always the same thing.

Sayer (2000) suggested that explanations of social processes typically depend on actors' interpretations, through much can happen which is unacknowledged or unintended or unknown. Additionally, he indicated that what causes something to happen has nothing to do with number of times it has been observed to have happened. Explanation in critical realist research depends on identifying causal mechanisms and how they work, and discovering if they have been activated and under what conditions, and considering the effects of the activation of the generative mechanisms. In Chapter Seven, I explain the generative mechanism of learning in an irrigation association.

Mollinga and Gondhalekar (2014) explained further that different configurations of mechanisms can produce the same outcome, while a particular mechanism can produce different outcomes in different circumstances; for example, a range of different mechanisms can lead to improved or commercialised food production in smallholder irrigation contexts, or the power-based policy mechanism that is actualised in the event of the community-based irrigation scheme policy of Mozambique (explained in Chapter One) can produce different outcomes when operative in the diverse case study contexts, Massaca and Macubulane (and others). Mollinga and Gondhalekar suggested that it is important to also understand the structures from which the mechanisms, as emergent properties, derive and they suggested that mechanisms are ontologically grounded in deep-seated structures. For example, the mechanism of a policy and the way it functions is often related to deep-seated power structures in society.

A crucial implication of critical realist ontology is the recognition of the possibility that powers may exist unexercised, and hence that what has happened or been known to have happened does not exhaust what could happen or have happened. The nature of real objects present at a given time constrains and enables what is, but does not pre-determine what will happen, as there is always agency in open systems that can shape what can potentially happen. I have explained in Chapter Two that in irrigation systems causal powers exist and can be exercised or not and that these can potentially be activated in learning processes.

In Chapter Seven of this research I consider, in the context of the case studies of Macubulane and Massaca, that there are visible that powers exist, but which are not exercised. In this context, critical realist methodology is based on explanation, and identification and further explanation of causal powers and structural changes. Critical realism thus allows researchers to access learning potentials, and learning dilemmas, and to explain what shapes learning in a given context, in the case of this study in irrigation systems management. Important here, is that critical realist ontology therefore allows researchers to understand not only what is (being), but also what is possible, and to understand how we could be or become many things which we are not (yet). As Bhaskar (1993) says, the employed could become employed, the ignorant could become knowledgeable, and so on.

Stones (1996, p. 49), drawing on critical realist philosophy, suggested that what actors do at a given time is likely to be affected by dispositions that were sedimented at some earlier stage, often in different places, and "… in the sense, the past and other places (now absent) are present in here and now". Critical realism also draws attention to the fact that frequently, two or more objects are contingently related in the sense that each could exist without the other, are brought into contact and interact (i.e. causally influence one another). Once this happens, certain further, new mechanisms may arise which influence becoming, and being.

Typically, therefore, social scientists deal not only with life in open systems, but with the reality that life in open systems is shaped by and constrained by many interacting structures and mechanisms. This creates the risk of attributing one mechanism (and its structures) to effects which are actually due to another (potentially also unknown) mechanism; hence Bhaskar (1979) warns researchers that their knowledge of the world is always fallible, and that it is impossible to attribute positivist causality to phenomenon in the social world. As noted by Vandenberghe (2015), Bhaskar has effectively dealt with positivism in the social sciences by showing its impossibility. Thus, as recommended by Bhaskar (1979, p. 69), in analysis it is important that critical realists are able to reflect in their research that "the relationship between causal mechanism and their effects is not fixed, but contingent" (p. 69). Analysis is therefore intricately dependent on the context within which mechanisms operate.

Sayer (2002, p. 25) suggested that historical narratives "need to relate satisfactorily to the ideational and the material. Ideas, ways of thinking, political paradigms can all produce change …. Whether such discourses can become effective in producing change depends on their practical adequacy, on how they relate to the constraints and opportunities of the context in which they are proposed". Thus, research requires what Jessop (1990) described as a "strategic relational approach" which considers how "actors, actions and contexts articulate. We need to know not only what the main strategies were of actors, but what it was about the context which enabled them to be successful or otherwise" (Sayer, 2002, p. 25). Researchers need to seek understanding of what it is about a context which allowed a certain action to be successful (or not).

For social sciences analysis, the social and cultural context of the phenomenon studied is crucial for understanding the operation of causal mechanisms (Bhaskar, 1979). And importantly for this study with its interest in learning, realists hold that mental concepts, values and inherent powers all refer to real entities, and that these entities are causally relevant to explanations of individual and social phenomena. Emotions, beliefs, values, and so on are part of reality. They are not simple abstractions from behaviour or epiphenomena of brain states. Putnam (1999, p. 77) noted that "realism in this sense is therefore not identical with materialism, nor is it simply a cover for a reductionist agenda that would attempt to eliminate such concepts from scientific discourse". For a study on learning, it would therefore be important to recognise these dynamics of the real, and such an approach would require inductive, abductive and at times retroductive modes of inference, and rich qualitative data.

Realist researchers would, from a methodological and analytical perspective:

- recognise the reality and importance of meaning, as well as of physical and behavioural phenomena, as having explanatory relevance, and acknowledge the essentially interpretive and thus also potentially limited or fallible nature of our understanding of the former (i.e. they recognise transitive and intransitive dimensions of reality; epistemic relativism, but ontological realism);
- emphasise the importance of the context of the phenomena studied, rather than seeking only general or generalisable understandings of specific conditions; and
- support the concept of emergence in open systems and a complex configuration of generative mechanisms as shaping emergence, rather than ontologically monovalent attempts to demonstrate correlational causality or association between variables. (Maxwell, 2008; Sayer, 2000)

While realism shares with interpretative social science a view that social phenomena are concept-dependent and have to be understood, unlike interpretivism it argues that this does not rule out causal explanation, a) because material change in society has to be explained too, and b) because reasons can also be causes, in that they prompt us to do things, and to think differently. In other words, critical realism poses a wider conception of causation than is customary, in that it does not assume that all causes must be physical (Bhaskar, 1979, 1989).

As this study is focussed on transformative learning, it is also possible to argue that a critical realist approach to research is both important and significant, as the study is seeking to not only interpret what is (being as experienced and reflected by participants) but also what is becoming (i.e. support expanded learning and activity) and thus to intervene in the transformation of the respondents from the perspective of mental, emotional and social structures (Guba & Lincoln, 1994). Broadly, critical theory research critiques and seek to transform social, political, economic, ethnic and gender values and structures, which is also the emancipatory intention of critical realist research.

To demonstrate how such a form of analysis can be applied to irrigation system research, I drew on an extended extract from the research of Mollinga and Gondhalekar (2014, p 191):

> … the 'primary case' research (step 1) on unequal water distribution in canal irrigation found that credit and employment relations (between large- and small-scale farmers) were internal relations of the structural configuration of the political economy of water management, that is, they were a defining part of the causalities generating unequal distribution of water. It was also found that, for instance, caste relations were externally related to this structural configuration and only contingently shaped unequal outcomes. That this was not an individual attribute of the particular situation intensively studied, but a characteristic with robustness across situations, could be established by comparing the intensively researched situation with other situations in similar irrigation systems (Step 2) … The same structure exists and produces similar outcomes across a number of situations because the same mechanisms are at work, and when similarity in outcomes (events) does not exist despite the structure being in place, other structures and mechanisms can be traced to explain this lack of regularity…. Further, stepwise comparison can help to distinguish the qualitative differences between the different instances of a particular kind of structural configuration (in the example, the set of components and relationships generating the mechanisms that explain unequal water distribution). In a critical realist perspective specific, robust configurations or sets are not unique or singular, but represent 'types' because reality is structured and layered, with configurations exhibiting endurance, against ontologies that are 'flat' (and aim at generalisation, based on regularity in 'events') …

3.6 Validity and credibility

There are various strategies available to researchers to enhance validity, credibility and trustworthiness of the study (Strewing & Stead, 2001; Maxwell, 2008; Merriam, 2009). Some of these strategies and how this present research engaged with them are described below.

- Adequate engagement in data collection or intensive long-term involvement: In this study I aimed to be closely and regularly engaged with participants twice in semester from 2012 to 2014 to better understand the processes in the contexts as thoroughly as possible. This provided me with more complete data about the specific situations and events.
- Rich data: I made an effort to generate and capture 'rich' data, both through long-term involvement and intensive interviews, which enabled me to collect data "detailed and varied enough to provide a full and revealing picture of what is going on" (Maxwell, 2013, p. 126). Video recordings of the Change Laboratory workshops ensured rich data of the learning interactions associated with Goal 2. This is because I was involved in facilitating the Change

Laboratory workshops and, thus, needed to capture data for later reflection, while I was involved with the facilitation.

- Respondent validation, member checking: To ensure internal validity of the data, I used respondent validation by mirroring the data in the Change Laboratory workshops to participants and in follow-up discussions through research activities. Feedback was also obtained on the emerging findings and interpretations from some of the interviewed participants. This helps to rule out the possibility of misinterpreting the meaning of what participants say and do and their perspectives, as well as identifying my own bias of what I have observed (Maxwell, 2008; Merriam, 2009).
- Searching for discrepant evidence and negative cases: Identifying and analysing discrepancy and negative cases is a key part of the logic and validity testing in qualitative studies. Instances that cannot be accounted for by a particular interpretation or explanation can signal important limitations in that interpretation or explanation. The basic principle here is that I rigorously examined both the supporting and discrepant data to assess whether it is more plausible to retain or modify the conclusions. As Wolcott (1990) noted, researchers need to be constantly aware of any pressures to ignore data that does not fit their initial conclusions. He recommended that in particularly difficult cases, the best option is to report discrepant evidence and allow readers to evaluate this and draw their own conclusion.
- Triangulation: This strategy involves using multiple methods of data collection, which meant that participant accounts obtained through interviews were checked against observations I made on site, as well as the data obtained from documents relevant to the phenomenon. In this way, multiple sources of data were collected at different times, in different places, and interview data collected from people with different perspectives could be compared and cross-checked.

Given the emancipatory intent of praxis-oriented research, I used what is called the less-known notion of *catalytic validity* (Brown & Tandon, 1978; Reason & Rowan, 1981). Catalytic validity represents the degree to which the research processes orient, focus, and energise participants toward knowing reality in order to transform it. The argument for catalytic validity is premised not within a recognition of the reality-altering impact of the research process, but also in the desire to consciously channel this impact so that respondents gain self-understandings and ultimately, self-determination through research participation efforts to produce social knowledge that will advance the struggle for a more equitable world, thus pursuing rigour as well as relevance. This accords with the interventionist research methodology discussed above in section 3.3.2**.**

Because this research deals with inference I have also reflected on internal validity/credibility: in qualitative research this relates to the internal coherence of the study from a theoretical, methodological and research process and outcomes perspective. Qualitative research deals with establishing a phenomenon in a credible manner. In this study, I sought to establish insight into the phenomena of transformative social learning in a credible manner that required me to also carefully focus on critical realist *generative mechanisms* or *causal powers* as described in section 2.5.3 (Tsoukas, 1989; Sayer, 2000). In this study, I used case study research to locate generative mechanisms and possibilities for transformative social learning as explained above. In case studies, validity can be established by the use of case analysis (see Chapters Four and Five), cross case analysis (see Chapter Seven), pattern matching, assurance of internal coherence of findings, expert peer review, and development of diagrams, illustrations and data matrices to demonstrate the internal consistency of the information collected (Yin, 1993). Further activities to demonstrate internal validity include precisely distinguishing the unit of analysis (see Chapter Seven), linking of the analysis to prior theory identified in a literature review (see Chapters Two and Seven) (ibid.).

3.7 Ethics and the role of the intervention researcher

Ethics is a system of morally constituted rules of behaviour that provide researchers with codes of conduct for researching in a morally defensible way (Schwartz, 2001). In order to ensure that all participants are entirely informed about the research purposes, the methods, intended uses of the research and what their participation means in this research, a letter of consent was developed.

The confidentiality of information delivered by research participants and the anonymity of respondents was respected and considered. Research participants were invited to take part in the research voluntarily, free from any coercion. Any harm to research participants was avoided in all instances. The video and photographic data were used for internal research-based purposes only.

I sought to respect the ethical principles for case study research as put forward by Bassey (1999) namely:

- Respect for persons: out of respect I wrote initial invitation letters to the Irrigation Management Boards presenting formally my interest to work with them in this research study. I also set up a meeting to explain the process of research and institutions to be involved. In the meeting, I made sure that each participant was able to share their thoughts during the discussion. I recorded all workshops and shared back later what was said in summary in the workshop and its relevance.

- Respect for democracy: Each participant had an opportunity to present their views. For those who had difficulties with English, I waited for them to speak and then translated for all participants; subsequent workshops after Change Laboratory Workshop were useful to bring back findings and new concerns. The Change Laboratory method used in this research is based on democratic interests in research, as it is based on the principle of enabling multi-voiced engagement with a changing activity, with co-ownership of the changed activity being premium. As stated by Virkkunen and Newnham, (2013, p. 22) "The socio-cognitive processes take place in in the Change Laboratory in the participants' and the researcher-interventionists' multi-voiced dialogue in which all the participants learn from each other. The public discourse in the sessions reflects and supports individual participants' inner processing of the conflicts between their various motives that the analysis of the activity and the discourse bring forth or aggravate". In this study, I tried at all times to enable the principle of allowing for a multi-voiced perspective and engagement with the object of activity, in which my voice was but one of the range of voices that were discussing the irrigation scheme activity. In expansive learning research, it is also important that the researcher, as interventionist researcher, does not prescribe the approaches for planned change, but rather merely provides the enabling condition for collective engagement on planned change approaches. In doing this, the researcher can ensure that he or she adequately respects the agency and expertise of the practitioners whose activity the intervention is setting out to change.
- Respect for truth: In my attempts to show a respect for truth in this study, I used the critical realist framework which urges researchers to seek for explanatory depth, and not to superficially interpret research problems, or to make the mistakes of methodological individualism or epistemic fallacy, or to limit one's research with ontological monovalence. I have discussed the implications of this for seeking truth in the social settings, which Bhaskar reminds us, are open systems, and thus our knowledge of them is fallible. Hence researchers also need to practice reflexivity as recommended by Price and Lotz-Sisitka (2016). Reflexivity is therefore not only a validity / credibility mechanism, but also an ethical practice in research, more so in interventionist research. Bhaskar (1993) described reflexivity as follows: "In its most basic form it specifies the capacity of an agent or an institution to monitor and account for its activity". But Price and Lotz-Sisitka (2016, p. 34) suggested that reflexivity in research is not a simple matter as researchers, because they are part of the research context, "are themselves

> limited in terms of their analysis to the extent that they themselves have been able to overcome the structural, ideological influences to which we are all subject". They suggested that critical realists acknowledge that researchers are part of the research context, and that they themselves must also be transformed by the research process. They need to take account of this as far as they possibly can, and Price and Lotz-Sisitka suggested that this should be done by taking account of theory/practice inconsistencies.

Thus, one of the key ethical issues that I had to consider was my own role in the research. As expansive social learning is a type of formative interventionist research in which the researcher uses approaches such as the change laboratory workshop to support and expand learning, researchers need to consider what this means from a reflexive research practice perspective. In this regard, Virkunnen and Newnham (2013) suggested that formative interventionist research approaches are both needed and viable, as researchers in their general practice intervene in the world, with performative effect. They suggested that researchers 'get serious about it' and analyse their own actions and research practices as they relate to those of research participants i.e. become more reflexive of our research practices. They suggested further that interventions occur all the time that researchers do not have a monopoly on interventions and should therefore not over-estimate their interventionist role in society and should recognise it as one form of intervention amongst others. Importantly for this study and its internal coherence and ethical intent, is their point that "by intervening deliberately and methodically we generate knowledge about what is possible", which they describe as "dynamic possibility knowledge" (Engeström, 2007). They stated further that, "Possibility knowledge opens up insights into what may be possible in a human activity and what alternative directions of development and change are available". Furthermore, from a reflexive research perspective, they noted that researchers should also understand that "Possibilities are not given; they are created and articulated by those whose lives are at stake", and this requires researchers to work in respectful, open minded ways with research participants. Possibility knowledge is generated by setting the activity and its subjects into motion, into some form of focused "time travel" that explores the past, the present and the future in relation to one another. Such modes of engaged world making are rarely captured without deliberate intervention" (p. xvii).

Pointing to some of the ethical considerations in formative interventionist research and use of the Change Laboratory method, Virkkunen and Newnham (2013) also warned researchers to take full account of the constraints on the use of the method, and suggested that it is important that the method be used in contexts or situations where practitioners “feel safe” to “freely express their opinions and are allowed to experiment with new ways of acting”. The method also calls for participants “to show willingess to exert themselves, get involved and take a risk” (p, xix). Thus “both the participants and the researcher-interventionists are brought in the Change Laboratory intervention outside their confidence zone and taken into unknown domains that call for and enable creative solutions from (p, xix) them”. There must therefore be a willingness to engage together on a common object in ways that may be as yet unknown to both parties, the researcher interventionist and the participants. In this study, I made efforts to ensure that participants were aware of this dynamic in the research process.

3.8 Synthesis

In this chapter I have approached the methodology applied within this research which encompasses the activity system methodologies including the method of development work research using Change Laboratory workshops in the research sites. I also presented social learning analytical tools, and discussed the implications of a critical realist approach to research for the analysis of data.

I gave a brief description of the methods of data collection, which include document analysis, individual and focus group interviews, intervention workshops and observation in the field. I also discussed how I sought to ensure validity and credibility in the study, and how I attended to ethics concerns with understandings of how these relate to the role and positionality of the interventionist researcher and his or her assumptions of research engagements and interventionist approaches.

CHAPTER FOUR

Case Study One: Learning in the Macubulane Irrigation Association

4.1 Introduction

This chapter aims to examine how and what kind of transformative social learning has (or has not) emerged in existing activity systems in the Macubulane irrigation association. The chapter begins with an introduction to key dynamics of the activity systems of the association (section 4.2). Then I discuss the contradictions in and between the activity systems as identified in the study (section 4.3). Further, I reflect on learning and changed agricultural practices related to the new irrigation schemes in section 4.4, and in section 4.5 I discuss the potential of transformative social learning in this association.

4.2 Dynamics in the activity systems in Macubulane irrigation association

4.2.1 The activity system concept

Russell (1997) advocated that it is necessary to have a comprehensive understanding of the activity system in which it occurs in order to elucidate the learning process, considering that the system's goals, beliefs and processes might affect what is being learned, and how the learning occurs. Activity systems are object-oriented, historically-conditioned, dialectically structured, tool-mediated human interactions (ibid.). It is therefore necessary to understand the object, history, conversation and tools employed within the system. Within a community, a group of people are responsible for the shared object of the community. Community is thus seen as the carrier or bearer of activity; applied to this case, it could be said that the community is the bearer of the activity of irrigation farming as it is transforming from rain-fed agriculture. How a community is defined and bounded depends on the concrete historical form of the given activity system; hence I provide a description of the concrete historical form of the activity systems as found in Macubulane irrigation association (section 4.2.3 below). According to Seppänen (2002), actions can only be understood in relation to the object and motive of an activity system; hence it was necessary for me to understand the shared object and the motive of the activity systems that were interacting in the Macubulane irrigation association context. Collective activity is driven by communal motive, which is embedded in the object and so the object is transformed by individuals involved in the activity over time, and therefore I also had to develop an understanding of the collective motive of the associations' activity systems.

As briefly introduced in section 4.2.1, activity systems contain several interacting and historically and culturally emergent components: subject, tools, object, division of labour, community and rules as shown in Figure 4.1 below. Seppänen (2002) described the key principles of activity theory. These include that the unit of analysis is an activity system, and that the activity is "an object-oriented, culturally and materially mediated system, with division of labour for knowledge and rules that regulate interactions between the participating individuals" (Seppänen, 2002, p. 132). Of central importance to the theory, which is of interest to this study, is the distinction between actions of individuals and collective object-oriented activity within this system.

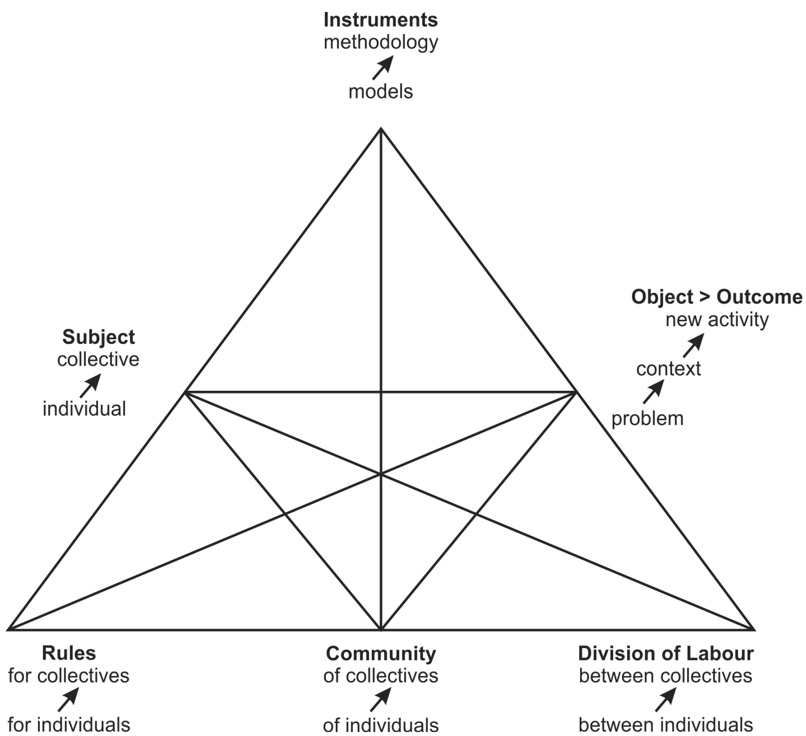

Figure 4.1: The structure of learning activity (Seppänen, 2002, p. 132)

Contradictions within and between the elements of activity systems can be identified and analysed. Seppänen (2002) indicated that contradictions can be seen as forces pulling in opposite directions in the activity (ibid.). Engeström (2000) pointed out that the concept of contradiction provides a theory of how movement occurs in complex systems, both (a) from action to activity, and (b) through different types of contradiction within the activity system. Dialectical thinking is considered to consist of sophisticated approaches towards resolving contradictions and inconsistencies (ibid.). Important for this study is the insight from activity theory that to understand learning as a phenomenon, it is necessary to understand the activity system in which it occurs, because that system, and its goals, beliefs and processes, affects what is learned and how learning occurs. It is important to understand that an activity system is "object-oriented, historically-conditioned, dialectically-structured, tool-mediated human interaction" (Russell, 1997, p. 501). Thus, it is necessary to understand the object, history, conversation and tools employed within the system.

In the Macubulane irrigation association, four activity systems were identified: (i) the committee board activity system), (ii) the educator activity system, (iii) the community activity system, and (iv) the sugar cane company activity system. The following sections describe the activity system framework and discuss the four activity systems in Macubulane.

To describe the learning in the activity systems, I adapted a framework from Uden (2007), which I explain in section 4.2.2. below. I describe the framework for identifying the activity, and for describing the dynamics of the activity system in context, and for analysing interaction across activity systems.

4.2.2 Framework for identifying, describing and analysing learning in irrigation activity systems

The first stage in identifying learning in the irrigation activity systems was focussed on the definition of the object of the activity. The irrigation system is comprised of several sub-system activities and each has its object or motives that are to be achieved. The sub-system activities (related activity systems that share the object of irrigation farming) are interconnected and it is important that the learning process investigation is oriented to the shared object of irrigation development.

This first stage allowed for investigation of learning processes in terms of the issues faced by farmers in the irrigation system, who is involved in irrigation learning, when and where problems occur, what the expectations of the irrigators are, and what might contribute to the success of the system. In this stage, I also examined the resources available to parties involved in the design and development of the irrigation systems, what tools and materials were accessible, what rules, norms and procedures were regulating the social interaction and coordination. In addition, I was interested to see if the target or intended technologies were integrated with other tools and materials that were being used, and what the roles of existing technologies were in the irrigation system learning contexts.

In the second stage, I took the collective activity system as the unit of analysis, as this helped to give context and meaning to seemingly random individual events. In this process, the first step was to understand the different groups of actors who were involved in the learning process, and to understand the way in which the labour was being divided among the actors, the mediating artefacts that were being used by the actors, and the rules that applied between the actors involved. The components of activity are described from the perspective of the key actors identified as the subjects of the activity system.

To identify and describe the activity systems, I used the following framework of questions, which I adapted from Uden (2007), to help me describe the activity systems and the interactions between subject, object, artefacts, rules, division of labour and context:

- **Questions relevant to the subjects**: Who are the people involved in this activity system? What are the respective roles? What is the outcome of the activity? What are the criteria to evaluate the activities? What are the rules of the members? And what is the division of labour within the activity system?
- **Questions related to the object**: What is the expected outcome of the activity? What criterion is used to evaluate the outcome of the activity?
- **Questions related to artefacts and tools**: What tools are used in this activity? Are they available to learners? What are the physical tools needed to perform the activity? What are the psychological tools used, including methods, procedures, theories or techniques? How have the tools changed over time?
- **Questions related to the outcome**: What is the evidence of the learning and agency in relation to irrigation system and outputs?
- **Questions related to the community**: What is the structure of social interaction surrounding the activity? How might conflict originating in the community affect learner interaction and achievement of the object? How have irrigation methods influenced farming communities?
- **Questions related to rules**: What are the formal and informal rules that guide the activities learners engaged in?
- **Questions related to the division of labour**: How have members taken on the different roles? How does that affect the work group activities?

In the third stage, I gave attention to **the analysis of the context** in order to understand the beliefs, assumptions, models and methods commonly held and used by group members, by noting how individuals refer to their experiences. Roher-Murphy and Jonassen (1999) suggested observing issues such as what type of limitation is placed on the activity by outside agencies, how tasks are organised, what the structure of interaction is surrounding the activity, which activities are considered to be critical, how flexible is the division of labour, the laws, norms and rules that guide the activities. This helps to describe the dynamism of the activity system. Context is both internal to people (involving specific goals) and external (involving artefacts, people and setting). In addition, it includes the location, technology, and environmental context of the irrigation system and management.

- **Questions to guide the analysis of the dynamics of the activity system** (adapted from Uden, 2007): Why are the people involved in this activity system? What are their roles? What is the outcome of the activity? What are the criteria for evaluating the farming activity? What are the rules (formal and informal)? What is the division of labour within the activity system? How is the work being done in practice in the irrigation system? How is work (actions and operation) transformed over time? Can any historical phases be discerned in the work activity? What are the goal motives of activity and how are these related to other concurrent goals? For each activity, what and how action is performed? For each of the actions, what operations are being performed by the subjects?

Because I was working with multiple activity systems that were related to each other and which shared the same object, I also needed questions to guide observation and analysis of the interface of the activity systems. Again, I adapted these from Uden (2007):

- **Questions analysing the interface of activity systems:** What are the basic limitations of the current technology and methods of irrigation systems? Are there conflicts between different goals? What are the criteria for the successful achievement of the goals? Are power relationships and hierarchies of power observable between the activity systems?

4.2.3 Activity systems and activity system dynamics in the Macubulane irrigation association

As indicated above, I describe four different activity systems that were identified in the Macubulane irrigation association, that all share the object of irrigation management development in a communal irrigation scheme context. These are:

- ➢ The management board activity system;
- The educators' activity system;
- The community activity system; and
- The sugar cane company activity system.

4.2.3.1 Management board activity system

Figure 4.2 that follows provides a graphic depiction of the activity system of the irrigation management board, which I describe in more detail after the graphic.

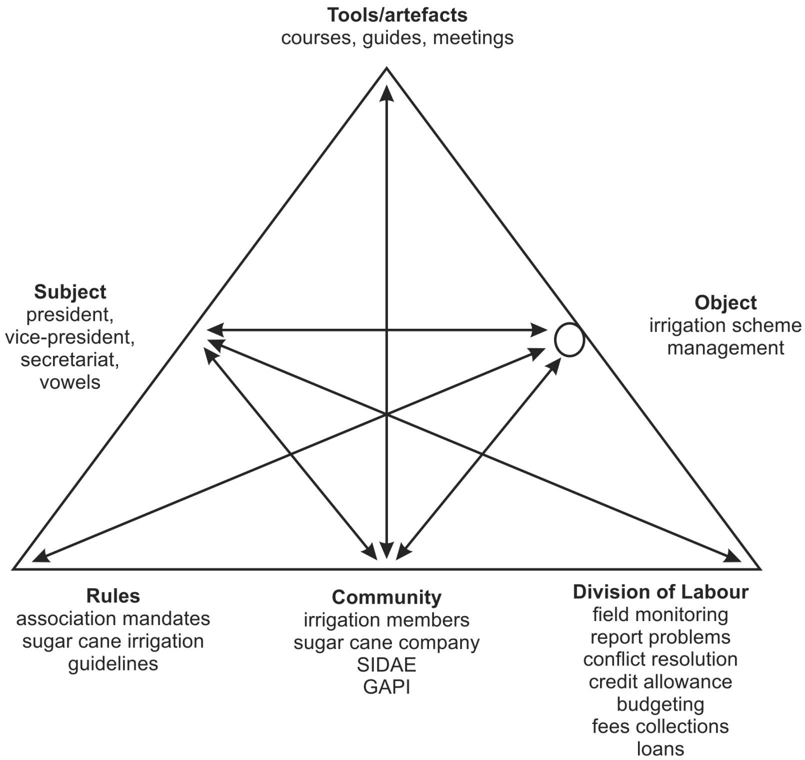

Figure 4.2: Representation of irrigation management board activity system

In this activity system, the subjects include the president, vice-president, and secretariat. The president is responsible for the activities of the management board. The vice-president does similar tasks to the president and takes over the president's role in his absence. The voting member does many activities, does not preside over any meeting, and fiscal management of the accounting activities and procedures of the association. Lastly, the treasurer is responsible for management of funds. All this is described in the statutes of the association. I could obtain more nuanced insight into this activity system via interviews with the board members.

The object of this activity system is to administer and manage the activity of the association, in order to guarantee the fulfilment of the association's objectives, which are to support farmers to successfully produce their crops, and to ensure this, their objectives are also irrigation objectives. This can also be seen as a key challenge of this activity system as the outcome is to guarantee the sustainability of the irrigation system.

The rules are also described in the statutes of the association. The management board has to guarantee fulfilment of legal dispositions, statutes and execute decisions as agreed upon and deliberated by the general assembly. They also have to submit an annual report and budget to the general assembly and report on the fiscal position of the association. A fiscal board member (the treasurer) represents the association in the meeting, and engages in financially oriented activities with stakeholders, including formulating contracts, and ensuring that there are adequate funds to acquire all that is necessary for the functioning of the irrigation system. As this is a communal activity, there is need to manage the finances for the common tasks, needs and objectives, as well as ensure that individual beneficiation occurs. Other rules include the national strategies and policies to support the transition from rain-fed farming to commercial farming (outlined in Chapter One), as well as the operational rules of irrigation conventions. There are also rules that are set up by the association itself that provide norms for the supply water level to the field. In the Macubulane irrigation association context, the water is delivered from the Incomati River to individual plots, which also follows a schedule according to the plant requirement. There are also specific rules related to the administration and managing of funds and loans of the association. The assembly is called by the management board, so that they can report back to members on the management of the association, and so that they can draw on insights and advice from the members, and discuss and deliberate the needs of the association members. Besides the deliberated rules that are agreed on within the general assembly, there are also customary laws and norms that are usually used for conflict resolution within the community. This involves the meeting of elders and local leaders where the issues are discussed. As one member of the management board explained in relation to their responsibilities related to conflict resolution:

> ***Respondent EDAMM1**: The conflicts we solve have to do with monetary issues, mainly when people borrow money from the association and then they do not give it back.*

The division of labour within the irrigation management board, includes the following range of tasks:

- Contracting outside workers for weed control;
- Irrigating the field;
- Monitoring the field;
- Conflict resolution;
- Framing new projects for the farmers;
- Balancing the accounts of the association;
- Representing the association in meetings with the sugar cane company;
- Providing loans;
- Collecting member fees;
- Paying bills (e.g. Energy, water, debts to GAPI and the sugar cane company);
- Maintaining the irrigation system;
- Cooperating with the sugar cane company and other stakeholders; and
- Increasing the sugar cane production per hectare.

The extract below from a focus group meeting probing the day-to-day activities of the board members shows how this division of labour is shared and distributed amongst the board members who are engaged in both office or committee based decision making, as well as in-field monitoring and management of technical aspects of the irrigation system's functioning. The focus group interview data with the management board shows some of the more nuanced dynamics associated with the roles, responsibilities, rule and division of labour of this activity system. The focus group data also helped to identify contradictions, disturbances and issues of learning (see extract below).

Data extract from a focus group with the management board on day-to-day activities of the board *(13 February 2013*)

Researcher: What are your daily activities (management activities)?

Respondent EDAMM1: *I'm a member of the association and I'm part of the board committee of the association. I'm treasurer and day-by-day I do the accounting of the association, I do payments of what we need to buy, pay the salaries, organise the financial documents, and work out the balances at the end of the month.*

Researcher: What constraints have you found through this activity?

Respondent EDAMM1: *The challenge is that most of the services are still not available locally, so they have to go to Maputo to get it. Those services include the repair of machines, tractors and the acquisition of equipment.*

Researcher: How do you process the subsidies for the workers if there is an unexpected or urgent issue?

Respondent EDAMM1: *We have an amount of money that we stipulate for salaries for the whole year and we get it after we have got the whole amount from the sugar cane sales. Part of it is for salaries and the rest for running costs. People do not believe what we say, but sometime when we ask for money to buy equipment they don't accept this and we just take money without the assembly's consent. This happens when something is broken in the irrigation system water intake station or for tractors when they are required. We do not go to the general assembly for permission to use available money in such a case, we decide to do it immediately. For example, we needed to change the sugar cane seeds, they asked the assembly for money for soil clearing and we suggested buying a tractor for clearing the soil. The assembly refused and said that was it was better to rent a tractor. We saw the benefits of buying a tractor and we bought it without the consent of a wide range of the general assembly members, but later they approved of our decision.*

Researcher*:* What do you every day (management activities)?

Respondent EDAMM2: *When I go to the field using my bike, I see what is happening. I come back to the committee and share some of the problems that I see in the field … Problems are often related to stealing of irrigation spares, sometimes the stubs get broken, and water leaks out. I take these problems to the office and inform the committee about what is getting damaged in the field.*

Respondent EDAMM2: *I am a member of the association and I help with irrigation assistance. Every day I go and see the places where the tubes are damaged and replace them.*

Respondent EDAMM3: *I am a voting member and my activity is to approve the budget when it is needed. I also go to the field to see what is damaged and what is happening during irrigation and clearing of the fields. I see if farmers are doing it according to our rules. I mostly monitor the contracted workers.*

Respondent EDAMM4: *I am a member of the association and vice-president. My work is to control the transport. When I arrive in the office I make an appointment and talk to the tractor driver to check the oil and the fuel. I then get information from them and clarify with the president what is needed. I also monitor and record workers that have come to work and those who have not come. The issues that I face include dealing with the machinery when the tractor breaks down, and when we don't have spares, and when the spares are broken. I also deal with the irrigation systems and issue irrigation spares*.

Respondent EDAMM5: *My work day by day as assistant is to deal with all the requisitions, whatever is requested. I have to register all material that breaks and that which is brought from the field. When we get materials from the field, I have to make a list of the broken stuff in order to ask for quotation for fixing it. I then ask for money from the treasurer in order to replace broken materials. Also, my role is to solve conflict. First associates talk to me and then we find ways if that does not work.*

Respondent EDAMM6: *I work with pumping machines, and deliver water to the field; we open the water and stop during the wet season because during this period there is enough rainfall and water moisture in the soil.*

Regarding the instruments and artefacts in this activity system, the management board had regular meetings in the morning. They also had wide-ranging assemblies that involved all members, where the president of the association got feedback from field monitors and the needs of the irrigation system were discussed. In summary, deliberation artefacts include meetings, manuals, training courses, the irrigation guidelines, and guidelines for cropping water requirements which were mostly facilitated by the extensionists. As can be seen from the interview extract above, other artefacts that were significant in this activity system were material and technical in nature, and included money, tractors, pipes, spares for equipment, and the knowledge and capacity to resolve problems related to the technical management of the equipment and machinery, as well as the management and distribution of the money.

Lastly, the community in this activity system included the irrigation associates and stakeholders, such as the sugar cane company, GAPI which is a Commercial Bank, working in rural banking finance and development. It operates with the private sector through expansion of a decentralised network of rural banks and other finance unities in order to guarantee inclusion in finance systems. It stimulates saving groups and provides loans and has been supporting Macubulane irrigation association by financing their activities and providing loans.

4.2.3.2. Educators' activity system dynamics

The next significant activity system in the Macubulane irrigation association is the educators' activity system, as depicted via graphic representation in Figure 4.3, and discussed in more detail thereafter.

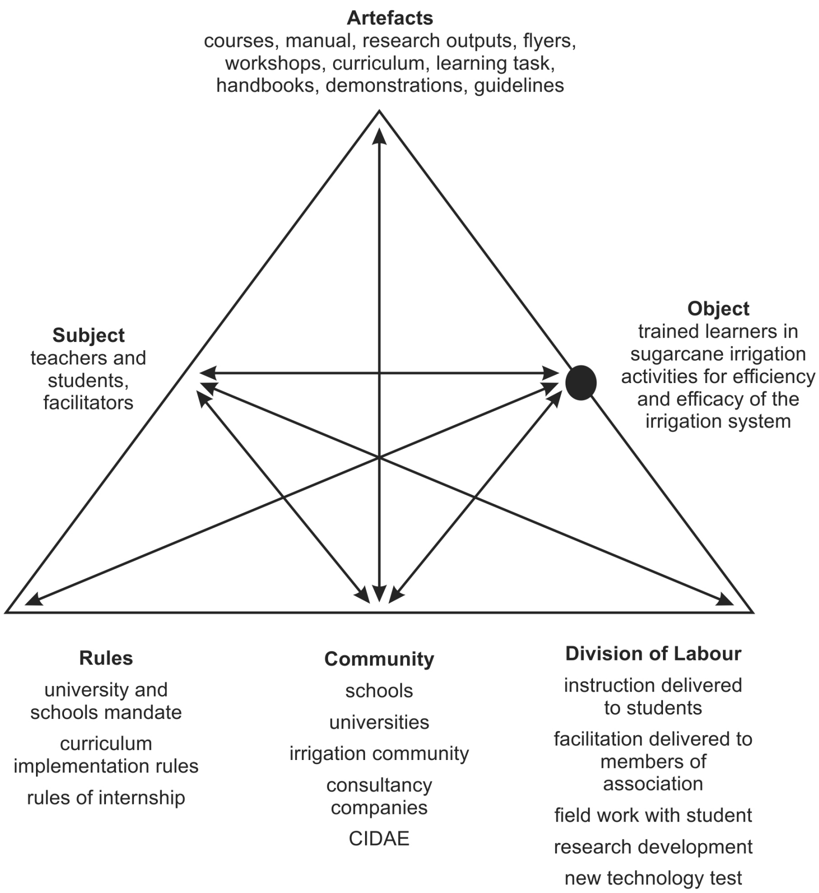

Figure 4.3: Representation of the educators' activity system

The subjects of the educators' activity system include the teachers, facilitators, and learners in the institutions that were associated with or involved in the Macubulane irrigation association learning. These include the agrarian institutes and schools, SIDAE (District Service of Economic Activities), which is the local government representative that includes agrarian services, the Agricane Company, Higher Education Institutions (HEI), and agro-agencies. The object of this activity system is to provide knowledge regarding sugar cane production and the operation and maintenance of the irrigation system to the communal farmers. The outcomes include trained learners in sugar cane irrigation activities for efficiency and efficacy of the irrigation system. The community here includes members of the irrigation system, education institutions, colleges, universities, schools, the sugar cane company, and the Local Agriculture Office. Artefacts include training materials and programmes.

In this case, the community was being trained mostly by the sugar cane company, and trainees were allocated to work with the association. The trainers had participated in formal education in agriculture, but were also specifically trained in sugar cane production with a responsibility to teach farmers. Formal courses are available in agrarian institutes and HEIs that train learners in the field of irrigation, agriculture, engineering, and environmental studies. The HEIs are responsible for training and research in the referred fields, curriculum development, and improvement of technologies for higher yield and productivity. Researchers also offer training to the community. For example, the Ministry of Mineral Resources organises courses on the use of mineral resources to improve agriculture outputs. This course has involved top researchers in the country as well as representatives of many irrigation systems. The workshop on mineral resource use for agriculture was promoted to the irrigation association with a focus on the use of minerals in farming production. The objective of the workshop was to train participants in the use of industrial minerals available for agriculture production in Mozambique. Participants learned: (i) basic geology of phosphor, calcium, and magnesium, and their function in plants, (ii) agro-geology as tools for sustainable development of plants, (iii) water loss mediated by diatomite in cropping maize, (iv) the effect of the use of dolomite in the control of insects, (v) the effect of dolomite in the regulation of the insect population, and (vi) evaluation of agrarian efficiency of the phosphate as outlined in the training manuals for this programme.

Selected farmers at the association have been offered training courses by GAPI on accounting, savings, and interest rates. In the beginning when the associations were established, the Incomati sugar cane company offered training on crop production and management to all farmers of the association. In summary, there were available courses, manuals, research outputs, flyers, workshops, curricula, and learning tasks that support the object of activity. There were also handbooks and a learners' internship programme from the colleges which allows young people who are being trained at the colleges to do field-based training and to assist with the object of activity.

Rules in the educators' activity system included mandates that govern the education institutions, and their mandate to reach out and assist farmers. The curriculum on irrigation and agriculture is also rule producing as the curriculum guides the way in which irrigation knowledge and practices are structured and transmitted. Wider education strategies and policies include expansion of teaching and improvements of competencies of graduates, and enhancement of education quality. The division of labour includes (a) providing courses, (b) curriculum development, and (c) research and field-based engagements (e.g. via internships, or field-based research that can support the farmers and the association and its functioning). The agrarian institutes provided curricula on irrigation and crop production, which is meant to strengthen the policy on communal irrigation scheme development, maintenance and management. Furthermore, the sugar cane company provided capacity building to the technicians from those agrarian institutes, specifically on sugar cane production and irrigation.

The extracts from an interview with a field instructor, shared below, provide further insight into the way in which this activity system is structured, and how it operates, as well as some of the interesting dynamics of the activity system.

> **Data extract from an interview with the field instructor (13 February 2013), focussing on learning practices in the irrigation system**
>
> **Researcher:** Where did you learn irrigation practices?
>
> **Respondent EDAMM7**: *I am an extensionist, working for the Xinavane Sugar Cane Company. I learned farming when I was studying in the Agrarian Institute. I received theoretical knowledge, such as how to crop, irrigate. I practised growing sugar cane when I came to Xinavane in the process of completing an internship with the sugar cane company. After my internship, and during preparation of the final fieldwork report, I could balance what I learned in the classroom and had seen in the field. After finishing my studies I was lucky to come to work here in the sugar cane company and implement what I had learned in the Institute, so we came with theoretical knowledge and put that into practice and it is easy for me to do.*
>
> **Respondent EDAMM7**: *I used to receive students from schools for six months in the field of irrigation. I taught them cropping, weed control, and chemical control of sugar cane plantations. I give them all the material on cropping and water supply during their internship.*
>
> **Respondent EDAMM7**: *I had additional training from experts in sugar cane plantation that came from abroad. I received files and materials related to operations and cropping and all activities after the cutting of the sugar cane in the irrigated fields.*

An extract from an interview below with the water machines operator, who was a member of the management activity system, showed how the training activity system interfaces with the management activity system.

> **Data extract from an interview with the water machines operator in the management board (May 2012)**
>
> **Researcher:** How did you learn those activities?
>
> **Respondent EDAMM6:** *I learned from the Incomati technicians who taught us how to operate machines. We had problems with floods and when this happened we moved the machines to a safer place. The rainfall allows the plants to grow in abundance and we only need the machines when the rainfall is low.*

4.2.3.3 Community activity system

The third identified activity system within the association is the community activity system, as depicted in Figure 4.4, and described in more detail below.

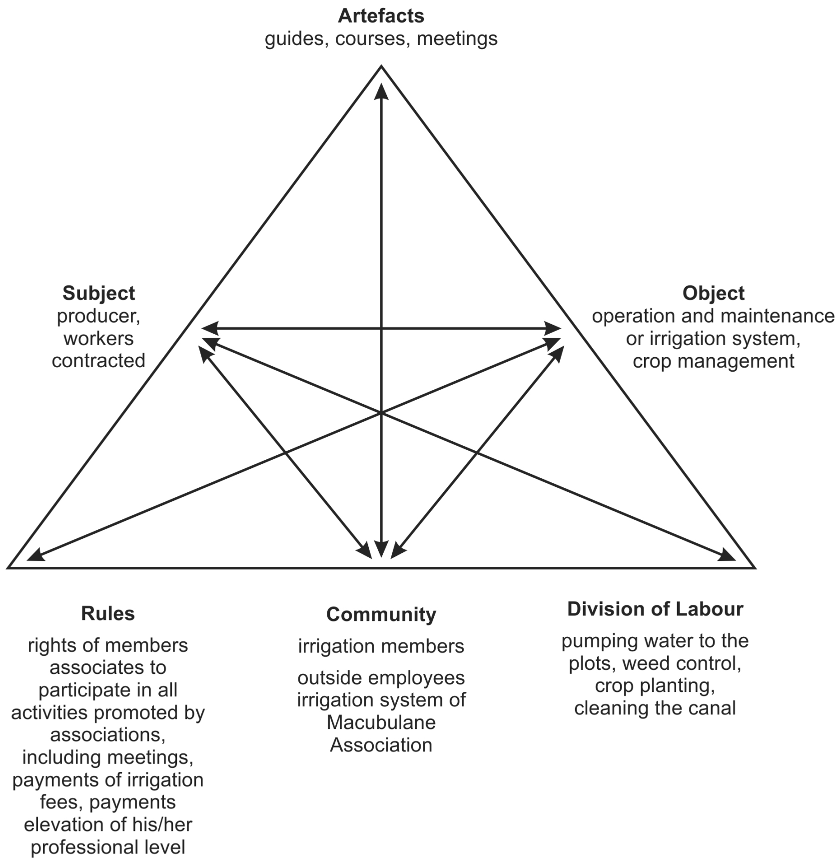

Figure 4.4: Representation of the community activity system

The subjects in the community activity system are the associate's members. The members have different backgrounds; for example, there are teachers, accountants, repairmen, and simple peasants. The farmers have had formal training in sugar cane production; however most of them practised rain-fed farming before joining the association.

The object entails sugar cane production, including plantation and crop management, and operation and maintenance of the irrigation system. The outcome of the system is an increased yield of sugar cane. The community of this system includes the workers that are contracted within the Macubulane community, individuals from different institutions, such as the sugar cane company that worked together with the association, and SIDAE (District Service of Economic Activities).

The community used artefacts such as meetings, operations and maintenance procedures, guidelines for operation, maintenance and crop management which they received from learning activities provided manly by the sugar cane company, SIDAE and researchers.

In terms of rules, the community used the mandates that were prescribed in the association statutes. They also adhered to customary laws to solve most of the problems or conflicts between members of the association according to the operational norms of the irrigation system. Members were expected to pay irrigation fees, be involved in the process of improvement of their technical and professional capacity, participate in learning programmes in the association, use in a rational way all goods of the association, and support all costs related to the rational use of the plot in the irrigation system. The members have the right to participate in all activities promoted by the association, including meetings and payments of irrigations fees. The division of labour in the community activity system included water supply to the field, weed control, routine monitoring of the activities in the field to see the process of irrigation and plant health, and transport management. See the extract below with the farmers' perspectives:

Data extract from an interview with the farmers (May 2012)

Researcher: How did you learn irrigation practices?

Respondent: IIMM1: *With irrigation we had good experiences. We started to plant sugar cane which we hadn't done before, change the sprinklers, at 6 in the morning, 12 and 6 pm. Initially it was difficult, and we learned to do it with a technician from sugar cane company.*

Researcher: How relevant were the courses that you received?

Respondent IIMM1*: The courses that we had were relevant because the irrigation system came from the community and we are the ones who have to make this system work. We have workers, now we are growing, we don't change sprinklers any more, we participate in the meetings, now they will call us to say how much money we have got per ton.*

Researcher: What learning makes this association efficient?

Respondent EDAMM6: *In the association we always need to have consensus; without consensus we won't work well, we won't reach our objectives.*

Respondent EDAMM1*: What makes us successful is the transparency; everything that we do and receive we share with members. We call a wide ranging assembly and show what we have gained in certain agrarian campaigns. We also show the farmers where we made mistakes. We also show which block had good yields and where people did not hoe or irrigate their plots, and because of that behavior, we lost production*

Researcher: What did the instructor from the sugar cane company teach regarding sugar cane irrigation practice?

Respondent IIMM1: *He taught us how to do maintenance of the sprinklers, cleaning them when they were blocked… the sugar cane we planted in 2006 we are changing step by step, putting in new seeds...*

Researcher: What do you do in irrigation association?

Respondent IIMM5: *My job day by day as assistant is to show all requisitions every day. I register all material that is broken and brought from the field – I make a list of broken stuff, then get quotes and ask for money from treasury to replace broken materials. Also my job is to solve conflict problems – first associates talk to me and then we find ways…*

Researcher: What are the conflicts?

Respondent IIMM5: *Sometimes the conflicts are regarding money, debts among farmers and with the association; sometimes farmers claim that there are farmers that are not supposed to be in the association because of their behaviour, and sometimes issues of land in association within a certain family – someone can claim to be the heir and it can be really complicated. We must solve the problem with the information that we have and it has not been an easy game.*

Researcher: And the issues of loans?

Respondent IIMM5: *For loans we meet the secretary of the association, the vice president and that treasurer in order to decide if we can give the loan or not … then we sign a contract. There are farmers that we don't trust because they don't use the loans for farming activities, they use them for other social issues.*

4.2.3.4 Sugar cane company activity system

The fourth identified activity system in the Macubulane irrigation association is the sugar cane company activity system, as depicted in Figure 4.5, and described in more detail below the figure.

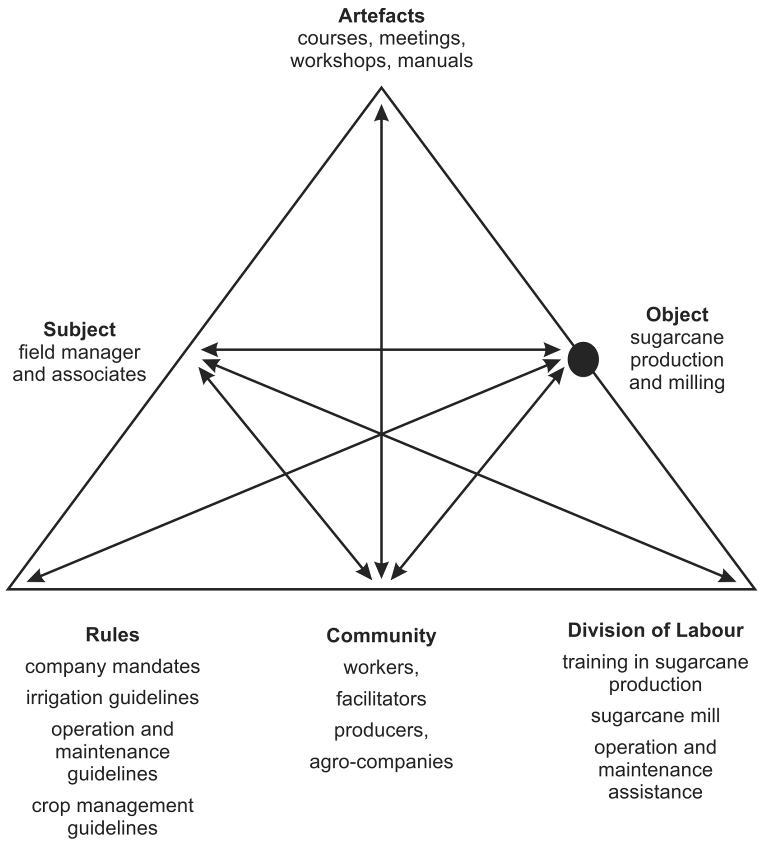

Figure 4.5: Representation of the sugar company activity system

The subjects of this activity system included the field manager, the small scale growers development sector which worked directly with the association, sugar company technicians, and peasants and the SIDAE representative. The object included sugar cane production and milling, and the outcome was increased productivity. The sugar cane company has proposed an expansion of the sugar cane area in order to increase sugar cane production and, while doing that, will support the community sugar cane irrigation association to improve efficiency, involving the local community (see extract below).

> **Data extract from an interview with small-scale irrigation coordinator (December, 2012)**
> *The Incomati sugar cane had external support for rehabilitation of the system and expansion of the sugar cane mill. We also started with the process of including farmers from outside association.*

Artefacts of this activity system included training courses provided by field managers, meetings, and field routine monitoring. The training in the sugar cane company consisted of topics such as irrigation, weeding, and fertiliser application. There is a manual that was used to train the local extensionist on sugar cane production, which focused on sprinkle irrigation design, operation and maintenance and planning.

The division of labour within this activity system was as follows:

- Provision of technical assistance to the irrigation association, harvesting, transport, infrastructure maintenance, and provision of fertilisers, herbicides, pesticides, and other inputs that are demanded in bulk;
- Provision of training courses in sugar cane production;
- Provision of credit;
- Coordination of activities with actors involved with the sugar cane company;
- Milling the sugar cane provided by the association; and
- Field monitoring.

The extracts below illustrate the kind of support provided by an irrigation co-ordinator and a field instructor.

Data extract from an interview with small-scale irrigation coordinator (May 2012)

Researcher: What kind of assistance do you give to association the farmers?

Respondent: *We provide technical assistance, in terms of maintenance of irrigation machines, operations in the field, chemical dosage. We also provide courses to the farmers and all communities, regarding irrigation, soil, varieties of sugar cane, pesticide, diseases, nutrition, and manure management. We also pay in advance the bills of power and water used in irrigation.*

Data extract from an interview with the field instructor (13 February 2013), focussing on learning practices in the irrigation system

Researcher: What irrigation practices do you develop with farmers?

Respondent EDAMM7*: I first organise a meeting before starting the activity with farmers and seasonal workers to explain what is supposed to be done during sugar cane plantation and irrigation. We harvest the sugar cane and send it to the company to mill it.*

In terms of rules, the company uses operational and maintenance guidelines, ordinary laws and policies to promote socio-economic development of the district and peasants. The community in this activity system includes agricane companies, technicians, peasants, and contracted outside workers.

4.3 Contradictions emerging within and between the activity systems in Macubulane

This section discusses the contradictions that were identified within and between the activity systems of the Macubulane irrigation association. As in section 4.2 above, it begins with a description of the framework that was adapted for the analysis, and then discusses the four main contradictions that were identified within the irrigation association system, involving the four activity systems and their dynamics as outlined above. The historical contradictions, which were documented contradictions that were identified by farmers and for which they themselves had identified the solution and implemented it already, were the subject of analyses. This was to see how confronting the contradictions influenced learning and transformation in the association (as of at the time of the data collection for this phase of the research).

Importantly, and for engaging the expansive learning intent of this study, some of the contradictions identified and described in this section were used as mirror data for the change laboratory workshop and further or expansive learning and expanded solutions were developed (see Chapter Six).

4.3.1 Contradictions analysis

4.3.1.1 Contradiction analysis framework

Activity researchers studying work, refer to deviations from standard procedures as *disturbances* (e.g. Engeström, 1996; Norros, 1996). According to Engeström (2000), disturbances typically indicate significant systemic contradictions and change potentials within an activity. As Engeström (2000) described, "while the object and motive give actions coherence and continuity, by virtue of being internally contradictory, they also keep the activity system in constant instability" (p. 964). Thus, contradictions within, or between activity systems create conflicts for the individual, which activity theorists refer to as a *psychological double bind* (Nowacek, 2011). Double binds are situations in everyday practices in which an individual receives "two messages or commands which deny each other" (Engeström, 1987, p. 174). In CHAT, contradictions are identified and categorised according to the basic structure of the activity systems (i.e. subject, object, artefacts, rules, division of labour and community), between different activity systems, or within an activity system at different stages of development (Engeström, 1987). CHAT does not perceive contradictions as mere inefficiencies that need to be avoided. They are rather seen as an unavoidable aspect of activity systems and the driving force of change and transformation. According to Engeström (1987), there are four levels of contradictions (primary, secondary, tertiary and quaternary – see below) in every activity system that need to be considered in an analysis by the researcher.

This present study adapted Uden's (2007) framework for the analysis of contradictions, which is based on Engeström's (1987) work, to identify contradictions between and within the activity systems of the Irrigation associations, as described below.

Framework for analysis of contradictions may include (Uden, 2007, p.98):

- What are the dynamics that exist between the components of the activity system?
- Are there contradictions or inconsistencies within the needs of various components of the activity system?
- What are the interrelations that exist within the components of the system?
- How have these relationships changed over time?

Potential **primary contradictions** in the irrigation systems may occur at node level of the activity systems, e.g.:

- Subject node (tensions within the subjects)
- Object node (tension between different types of learning)
- Rule node (tension between different procedures)
- Division of labour node (tension between different approaches to tasks)
- Artefacts and tools node (tension between different tools or uses of tools)

Potential **secondary contradictions** may occur between the nodes in the activity system, e.g.:

- between rules and division of labour; tension may occur due to unclear rules or regulations that determine the role of each actor involved
- different perceptions with regard to the object
- between community (society) and the object node (learning); e.g. when society focuses on problem-solving and thinking skills while learners may not be interested in higher productivity

Potential **tertiary contradictions** may occur when an activity is remodelled to take account of new motives or ways of working. Thus, they occur between an existing activity and what is described or seen to be a more advanced form of that activity (e.g. rain-fed agriculture and irrigation agriculture).

Potential **quaternary contradictions** may occur between the different co-existing or concurrent activity systems (e.g. between the farmers' activity systems and the irrigation board's activity system).

As can be seen from the above, this can be perceived as complex, interlinked, and as a continuing evolving 'web' of contradictions. These may emerge over time in relation to each other. "Primary and secondary contradictions in an activity may give rise to a new activity which in turn spawns a set of tertiary contradictions between it and the original activity and this is may be compounded by quaternary contradictions with co-existing activities" (Uden, 2007, p. 98; based on Engeström, 1987).

Within the irrigation schemes in this study, contradictions were identified through document analysis and a series of individual interviews and focus groups as explained in Chapter Three.

4.3.1.2 Primary contradictions

Primary contradictions emerge within the nodes in the activity system. The following contradictions were identified in the Macubulane irrigation association at this level.

- *Contradiction at the tools node between prior experience and current expectations*: Most of the individuals did not have formal instruction on sugar irrigation farming and thus the community was not familiar with sugar cane production, associated farming production systems, and yields. This was manifest in the discourse of farmers who stated that the members of the association had not practised sugar cane farming before in a commercial way, as shown in the data extract below:

  Data extract from an interview with the farmers (May 2012)

  Researcher: When and how did you start to practise irrigation?

  Respondent IIMM2*: Before I used to practice rain-fed farming here in Macubulane, we used to plant maize, cassava, vegetables, sweet potatoes and we used cows to hoe the field. In 2005 I started to deal with irrigation systems, and Incomati sugar cane association sent someone to teach us how to irrigate and hoe the fields. We hoe in December and January. And then in April, we did harvesting and now we are removing straw and some we keep in the lines in the soil to be composted… before we used to apply compost manually; now we use machines*.

  Respondent IMM1: *With rain-fed agriculture the problem was that when there was no rain, we had problems, and we practically had no food, because we use to plant maize, cassava, vegetables, sweet potatoes for eating and we used to hoe the field using cows.*

- *Contradiction at rules node between forms of knowledge required and used*: This contradiction was revealed by the need for different uses of irrigation knowledge in the new irrigation based farming system, and the traditional knowledge of farming held by the farmers, as shown in the data extract below:

  Data extract from an interview with small-scale irrigation coordinator (December 2012)

  Researcher: What are the challenges you find with the association farmers?

  Respondent: *The domain of business of farmers is very weak. Regarding payment for the sugar cane production, they don't know the financial laws.*

- ***Contradiction at the division of labour node*** between requirements for regular sugar cane irrigation during the day in the morning 6 am, afternoon at 12 pm and 18 pm and farmers' traditional routines of irrigation in which mostly farmers irrigate in the morning. Most farmers had houses and lived far from irrigation system and some farmers were unable to irrigate following the required schedule to irrigate the sugar cane fields or switch the sprinkler from one site to another, including weed control, reflecting low farmer availability in terms of labour capacity to irrigate. The implication was that some plots could not produce good yields, affecting the association's productivity. Those plots experienced reduced yields during harvesting, and this in turn affected the revenues from selling sugar cane. The reason is that sprinklers' irrigation methods needed more labour, as it is expected that the position of the sprinkler should be moved every six hours (see extract below).

  Data extract from an interview with the farmers (May 2012)

  Researcher: Why could farmers not change the asperser in time?

  Respondent *IIMM1:* *With irrigation, we had good experiences, we started to plant sugar cane – that hadn't been done before, change the aspersers, at 6 in morning, 12 and 6 pm. Initially it was difficult, because some farmers were old, others lived far from irrigation system so they were unable to come three times to change the position of asperser.*

- *Contradiction at tools node between knowledge needed and knowledge provided in the colleges curricula*: This was shown in the analysis of curriculum contents of the Magude Agrarian College and tertiary schools near in the area in Maputo City, which showed that the curriculum from the colleges and tertiary schools do not contain courses or subjects on integrated irrigation management. Yet, national policy requires farmers to co-operatively implement irrigation-based farming methods.
- *Contradiction at tools node between knowledge provided and knowledge needed for irrigation system development.* This tension was revealed in an analysis of the study plans of the agrarian schools and institutes and the manual that was used to train technicians in sugar cane plantation which shows that the training institutions and materials are more concerned with technical issues of irrigation, and are less concerned with issues of efficacy, sustainability and the social issues related to irrigation practices.

4.*3.1.3 Secondary contradictions*

The following secondary contradictions were identified since the establishment of the association.

- *Contradiction between subjects and object*: Some of the members were unable to hoe and irrigate the land using the sprinklers and change the sprinklers' position following the schedule designed for sugar cane planation. The reason for this was that some of the farmers were old and were unable to physically manage the labour regime which required them to come and clear the fields and change the irrigation systems position at 6am in the morning, at noon, and at 6pm in the evening. It was hard for some people, especially elderly farmers, as can be seen in the extract below.

> **Data extract from a focus group with the management board on day-to-day activities of the board (May 2012)**
>
> **Respondent EDAMM1:** *Many farmers used to practise rain-fed agriculture, and we learned irrigation farming when we joined the association. We had problems because we were taught to use the asperser and during the day farmers must change the position in the morning, midday and late at 6 pm. In the beginning this job was done by the members; however, we discovered that some members could not come to the field to irrigate … This affected the yield – we were less a ton of sugar cane at the end.*

- *Contradiction between subject's commitment to the collective objectives and the rules or policy objective of community-based irrigation scheme management* that requires collective decision making. This was shown up by the disturbance which had to do with generally weak participation of the members during the general assembly meetings. This resulted in the management board taking decisions on their own, and taking risks related to the collective decision making system that was required; for example, they decided to hire additional workers from outside to work in the field and to purchase a tractor (as reported on below).

> **Data extract from a focus group with the management board on day-to-day activities of the board (13 February 2013)**
>
> **Respondent EDAMM1***:* *Initially a few members used to come to the main general meeting and many did not agree with the suggestion of a Management Board. When we started in 2005, the yields were 20 tons and then 24 tons and then started to decrease to 22 and less and less, then we discovered that the farmers were not doing their work in the field and we suggested to the assembly that we introduce outside workers from the community to help to irrigate, hoe the fields and many farmers did not agree, saying we wanted to take jobs from farmers and we wanted to eat their money. But the situation was bad and we decided to employ outsider workers and the yield started to increase – we doubled it, and all farmers applauded the decision, were happy with the decision, and joined actively in the meeting. We also proposed buying a tractor instead of hiring one. Many farmers were against this and said that it would be expensive and it was better to continue to hire. The management board decided to ask GAPI for a loan to buy a new tractor that is now working; as result the revenue from sugar cane sales increased and we were still able to pay the bank back.*

- *Contradiction between the division of labour and the rules*: All farmers are paid the same amount after the sugar cane is sold to the sugar cane company, but not all farmers contributed equally to the labour process (hoeing the fields, moving the irrigation system regularly) required for the successful production of the sugar cane, for various reasons, some of which are shared above. This led to 'free riders' in the irrigation system. Ultimately this led to a reduction in yield in certain plots and a reduced overall yield for the association, which reduced the profits. All members were paid the same amount of money, even those who did not work very much during the year and had low yields. Additionally, some of the members were unable to pay back loans they were offered to pay for the irrigation of the field.
- *Contradiction between rules and object*: A further contradiction was identified between the embedded rules of the ecological system and how it operated, and the object which was to produce irrigated sugar cane. This was shown by the problem of poor soil fertility resulting from the sugar cane plantations, and issues of soil salinisation that occurred due to irrigation, making it difficult for farmers to maximise the soil productivity over time. This also reduced their options further (e.g. for using the soil for other purposes or forms of crop production). This is expressed in the data as follows:

  Data extract from an interview with small-scale irrigation coordinator (December 2012)

  Researcher: What are environmental concerns regarding sugar cane production?

  Respondent*: In the fields there is soil salinisation and in some fields sugar cane is not productive after five years – this can affect the productivity and yield, and we need to change the sugar cane plants after six and seven years' period of good yield.*

4.3.1.4 Tertiary contradiction between individual farming practices and need for immediate funds, and the irrigation scheme activities that are community-based and have collective irrigation scheme practices and expectations.

This contradiction was revealed by the following situation: In the beginning when the irrigation system was established, the process of crop management was the responsibility of the farmers which included cleaning the plots (hoeing), seed control and irrigation of the plots. However, some people were not able to do the work (for many reasons but mostly because some were older and were not be able to change the sprinkler according to the schedule). The association then agreed to give money to the members of association to hire outside workers do these activities. But members needed to use that money for other proposes due to financial stress, with the result that the productivity was affected negatively.

4.3.1.5 Quaternary contradiction between farmers' activity system and the sugar cane company activity system

This contradiction was shown in the economic system functioning of the community-based irrigation scheme, and the needs of farmers. Sugar cane crops grow and mature for harvest over a nine-month period and the harvesting is done once a year, which means that the members receive money once a year from the Sugar Cane Company. According to the farmers, the money is still not enough to support their needs during the rest of the year or until the next harvest as shown in this quote from the data:

> **Data extract from an interview with the farmers (May 2012)**
>
> **Respondent IIMM2***: Before we used to face problems because we used to farm depending on rainfall and if was not raining then we suffered a lot. With sugar cane we earn once a year after selling sugar cane, and the money is not enough – that's why we still do other farming activities at home. I produce chickens, and I get extra money.*

4.4 Learning of changed agricultural practices related to the new irrigation schemes

4.4.1 Motivation for learning in irrigation farming

Motivation is a concept that comes from a Latin word meaning "to move", and it is understood that a motive is something that moves an organisation to act. In addition, this concept has to do with the question of why we do things (i.e. influences on individual action). Printrich and Schunk (1996, 2002) noted that motivation is an important determinant of behaviour for learners, teachers and administrators at all educational levels. Motivation is relevant to the learning process and can be understood as providing the energy and direction for behaviour (Elliot & Covington, 2001). A researcher with a development focus needs to take both these kinds of motivation into account, i.e. personal achievements and motive, and social actions (Graham & Weiner, 1996). Social learning theorists such as Engeström (1987) and Wals (2007) appear to have viewed motivation as a key indicator of performance of both individual and cooperative goals, with potential transformative change in practices for sustainability. Learned changes in activity may not occur unless there is energy and motivation.

Graham and Weiner (1996) provided an historically constituted typology of theories of motivation which I drew on to interpret some of the motivational factors shaping the learning of farmers in the Macubulane irrigation association case:

Table 4.1: Features of the theories of motivation (adapted from Graham and Weiner, 1996)

Motivation theory	Contributors	Year	Focus and range
Drive	Hull	1940-60	Personal learning
Field	Lewin	1940-60	Task recall
Achievement	Atkinson	1940-80	Task choice
Social learning	Rotter	1940-90	Expectancy in skill vs. chance situations
Attribution	Heider, Kelley, Weiner	1940-90	Achievement, affect, helping

Source: http://www.unco.edu/cebs/psychology/kevinpugh/motivation_project/resources/graham_weiner96.pdf

In the Macubulane irrigation association, social, cognitive and biological factors played a role in the learning process of farmers in irrigation farming. With regard to social factors, affiliation appeared to be motivational, as farmers indicated in interviews (see extract below) that they joined the association because they had seen other associations producing sugar cane nearby. They observed that those associations were running successfully and were producing good revenue, and this stimulated them to join forces and form their own association with the belief that this would improve their livelihoods. They were also motivated by personal improvement in terms of competences and skills for irrigation practices, specifically as these related to sugar cane production. Another important motivational factor to learn was the need for solving problems while dealing with constraints, and eliminating risks (as shown in the interview extracts in sections 4.2.3.1 and 4.3.1.3 above). Farmers also appeared motivated to increase cognitive knowledge of irrigation activities and management, and to develop meaning or understandings beyond the irrigation management concept. Biological factors of motivation to learn also have to do with the intention to decrease hunger and discomfort. The interview extracts below illustrate some of these motivational factors:

Data extract from an interview with the farmers (May 2012)

Researcher: Why did you join the association?

Respondent EADMM11: *I joined the irrigation association because I wanted to improve my conditions.*

Respondent EDAMM2: *I come to the irrigation association because I was suffering with rain-fed farming, when there was no raining we couldn't crop anything, and we suffered from hunger.*

Responded EDAMM5: *We feel good in the association because when employing local people from the community, we are also helping them.*

4.4.2 Learning processes

In this section I discuss the learning process in Macubulane irrigation association which includes workplace and social learning including factors that influence such learning.

4.4.2.1 Workplace learning in irrigation systems

As discussed in Chapter Two, social theories of learning have emerged which foreground the situated nature of learning. Lave and Wenger (1991) argued that learning is always situated, i.e. that it is a function of the context, culture, and activity in which it takes place. Expanding on possibilities for interpreting situated learning in workplaces, Boud and Garrick (1999, p. 6) observed that:

> … the workplace has become a site of learning associated with various purposes. The first is the development of the enterprise through contributing to production, effectiveness and innovation. The second is the development of individuals through contributing to knowledge, skills and the capacity to further their own goals as employees and citizens in the wider society.

In order to address the issue of learning in the irrigation system, we need to consider what it is that farmers need to learn. Capabilities may mean that an individual has attributes, skills, knowledge, experience, and understanding of irrigation systems and its complexity. Agency is an important aspect of capabilities and refers to the ability to act in the world (Cundill et al., 2014). The Macubulane irrigation association uses a sprinkler type of irrigation that may require specific competencies in order to achieve and guarantee productivity. As can be seen from the data extracts and the description of workplace learning below, learning in the sugar cane plantation workplace has been facilitated by an instructor who has knowledge of irrigation and sugar cane plantation and production.

> **Data extract from focus group and interviews which capture insights on workplace learning in the Macubulane irrigation association**
>
> **Respondent EDAMM6:** *He taught us how to do maintenance on the sprinklers, cleaning them when they are blocked. The sugar cane we planted in 2006, now we are changing … planting new sugar cane plants …*
>
> **Respondent IIMM5***: The technician taught us to do irrigation, set the tubs, sprinklers, hoe the field …*
>
> **Respondent EDAMM8***: We had good experiences, we started to plant sugar cane which we haven't done before, we changed the aspersers at 6am, noon and 6pm. Initially it was difficult and we have learned to do it with a technician from the sugar cane company.*
>
> **Respondent EDAMM1***: After harvesting, the sugar cane company gives us the reports, we have members that control the car that gets weighed and we control the tons that were produced … I have learned to deal with the irrigation system of the Incomati Company. They have sent a person to teach us to irrigate …*

> **Respondent EDAMM6*:*** *Farmers have pluviometers; we measure rainfall and when rainfall is high, we tell them not to irrigate and we stop irrigating. We take samples of the soil, which is of a sand-clay type, and we test the soil moisture is. If there is water available in the soil, we stop irrigation.*

> **Respondent EDAMM6*:*** *I work with the pumping machines and deliver water to the fields. We open the water and stop during the wet season. I have learned from the Incomati technicians who taught us how to operate the machines. We had problems with floods and when this happened we removed the machines to a safe place. The rainfall allows the plants to grow in abundance.*

The data extracts above show that irrigators are able to practise most of the irrigation activities, such as operating the sprinkler irrigation systems, locating and clearing blockages in the irrigation system, locating and replacing faulty components in the irrigation systems, operating fumigation equipment, and maintaining the drainage system. However, the communities were unable to measure the irrigation delivery performance, monitor and operate water treatment processes, monitor and operate waste treatment processes, and apply principles of water management and hydraulics in the irrigation work. Formal training was developed by the sugar cane company to cope with these learning constraints. Table 4.6 shows the irrigation practices that farmers perform, and indicates which of these farmers knew about and were able to perform. I developed this table based on interview, focus group and observation data, and analysis of the training manuals.

Table 4.2: Required irrigation practices for farmers

Farmers' performance in terms of managing and operating sprinkle pressurised irrigation systems (draglines and furrow)	What they know	What they don't know
1. Locate and clear blockages in the irrigation system	X	
2. Operate sprayers	X	
3. Measure irrigation delivery performance		X
4. Monitor and operate water treatment process		X
5. Monitor and operate waste treatment process		X
6. Locate and replace faulty components in irrigation system	X	
7. Locate and clear blockages in irrigation delivery and drainage	X	
8. Apply principles of water management and hydraulics in irrigation work		X
9. Operate fertiliser and weed control equipment	X	
10. Connect irrigation system from drinkable water to potable supply	X	
11. Install irrigation system	X	
12. Install drainage system		X
13. Maintenance of the drainage/canal system	X	
14. Monitoring and evaluation	X	

Based on the analysis in Table 4.6 and as shown in the data extracts above, it is evident that learning had occurred in the Macubulane irrigation association workplace. The data also showed that farmers' learning is supported by technical instruction by a facilitator who was allocated by the sugar cane company to assist farmers. The instructor provided knowledge to farmers on how to deal with irrigation practices. Knowledge was transmitted during demonstrations on how to do things or how to apply a certain technology. This process allowed farmers to read and learn faster in the field.

I also observed that the facilitator was responsible for monitoring and evaluation activities involving careful monitoring of irrigation requirements in the Macubulane irrigation association. Before water was delivered to the soil, samples were taken to the laboratory to ascertain the soil moisture and see if it correlated with the precipitation. If the precipitation was around 58 mm, then they would stop irrigation because the soil contained enough moisture. The process of learning to take soil samples to test soil moisture content was also noted by Respondent EDAMM6 in the interview citation above.

Irrigators have been learning how to plant sugar cane, change the seeds, and practise seed control. They have been learning by putting into practice knowledge from the training process. However, the farmers faced many challenges that influenced the learning process, such as the need to be in the field during the day to change the sprinkler position as was described in section 4.3.1.3 above. This required additional effort, compared with rain-fed practices, where farmers went to the field only once a day in the morning.

People interpret and use what they learn in different ways. For example, farmers used to apply compost and herbicides manually in the field; once the facilitator explained the advantage of using spray for herbicides, some members were initially reluctant and the instructor had to be persistent to convince farmers to make the shift. Today farmers use machines and herbicide sprays and they are able to apply appropriate quantities in terms of control and careful use of chemicals, as shown in the data extract that follows.

> **Data extract from an interview with the field instructor (May 2012), focussing on learning practices in the irrigation system**
>
> **Researcher:** What constraints did you have with farmers?
>
> **Respondent EADMM7**: *I had a problem because I have to follow a specific farming programme in the field and after six months it's necessary to apply manure and spay, and I had to ask them to change from manual spray to mechanic application and farmers were reluctant. So I had to explain the advantage of using machinse such as tractors to put fertiliser in the soil and spray. It was really difficult, but then they understood and accepted. Now I can follow the programme and those activities are done in time.*

4.4.2.2 Social learning in new irrigation schemes

As already discussed in Chapter Two, there are various ways of describing social learning, but essentially it is about bringing together answers to certain issues (Wals et al., 2009). "People with various background and different values, perspectives, knowledge and experiences, both from inside and outside a group or organisation, come together to engage in a creative quest for answers to questions that have no ready-made answers. Social learning is a process in which people are stimulated to reflect upon implicit assumptions and frames of reference, in order to create room for new perspectives and actions" (Wals et al., 2009, p. 11). As can be seen in the data extract below, in the Macubulane irrigation association, learning practices also occur through a social learning process. Changes in understanding can occur through learning of new factual information, which increases awareness about important issues, as can be seen in the extract below.

Data extract from interview with the Macubulane association field instructor, (May 2012)

Respondent EDAMM7*: As an agent I used to organise workshops. Before starting the activities, I call the farmers and seasonal workers to explain that we are going to start the activities in the irrigation system and we have to work in such a way that we get what is expected. In terms of content, I explain the herbicide application in the soil, I explain the chemical content of herbicides and the methods of application. It is necessary to not only tell them but also to practise, show the doses to be applied, when it should be used and when to apply to the soils. If there is a wind, there is a need to calibrate and take the spray and show how to apply it. I show farmers how to spay correctly because they can lift the machine up and burn the sugar cane leaves. I explain to them that there is herbicide for pre-emergent and post-emergent conditions. Pre-emergent is applied before emergence of the weeds and post after.*

Respondent EDAMM7: *I explain to them the advantage of using a manual type of fertiliser from the mechanical type of machine for composting. That was difficult for them to understand, and now all of them have got knowledge of the machine for composting and I'm able to fulfil the programme.*

Respondent EDAMM7*: Working in the association is complicated, mainly because people have in mind that their plots belong to them, so I must behave in a simple manner and listen to their ideas and know how to correct them, and have good experiences in working with farmers. This has helped me to grow in my activity. So, the members also do follow-ups in the field and when they see something wrong they call me and tell me the problem, which I'm sometimes not aware of. I have a little knowledge on rural extension services, I know how to talk to the farmers, how to use simple language in order for them to work freely, to avoid harming them, and to do that we need to talk and I learn from them and they also learn from me, because I came here, they have been working here and I come with my techniques. I teach them all I know and they give me feedback. Sometimes they recognise that somewhere they were wrong in doing things.*

Respondent EDAMM7*: The process of hoeing falls under my responsibility, general supervision, yields per hectare. I do verification and asked the farmers their availability in terms of hoeing, and show them the channels that they have to clean; I used to calculate the yields per plot. Once the collected sugar cane is milled, a report is provided that gives information of the total yields in all for the association, and profit per plot.*

The data extracts above show that social learning in the irrigation association was stimulated by constraints that farmers faced during the activities in the workplace learning contexts and in the planning and administration process. The social learning process in the workplace came to the fore (i) through emergent issues that arose from the process of crop management, and in applying of new technology to ensure higher productivity, and (ii) in the process of irrigation planning and administration, regarding constraints with irrigation farming, irrigation monitoring, water supply, finance management, and conflict resolution.

The mechanics of social learning in this context included farmers working in small groups on key activities relevant to the practice of sugar cane production that was engineered by instructors who had considerable knowledge and competence in irrigation practices and were willing to work with farmers with different behaviour, ages and levels of literacy. Farmers were exposed to, and begin to interact with, new technologies and sometimes they were not aware of the way they did things and how application of new technologies affected the yields. Therefore, while using the new technology, emerging disturbances may have arisen while applying this knowledge and technology or when the expected productivity per plot was not achieved. The facilitator was always in the field to support the producers during planting, irrigation, and seeding, and as can be seen above, he adopted a reflexive, helpful approach to supporting farmers. Such learning was not necessarily planned, and it required a reflexive, engaged approach to sharing knowledge in context, amongst both the facilitators and the farmers.

As shown in some of the data reported on in section 4.3.1 above, the administration and planning activities in the irrigation system were a source of difficulty. During my fieldwork period, I observed that social learning was most commonly emerging at the level of administration and planning activities in the irrigation system. As noted in section 4.3.1, constraints were observable in form of contradictions that the management board faced in running the activities. I observed that once the problem was identified they tried to solve it through social learning processes involving the management committee, or the management committee with members, or the management committee with the Agricane company (i.e. either within their own activity system, or across interacting activity systems). The extract below illustrates this.

Data extract from 13 February 2013, showing outcomes of social learning after dealing with dissonances

Researcher: Is the meeting helping the association?

Participant CLWMM2*: The meeting helps when we have to shift the scheme.*

Participant IIMM1*: The courses that we had are relevant because the irrigation system belongs to the community and we have to keep it working, we work on it and we are growing, we change the aspersers, we participate in the meetings, now because we are collecting the sugar cane, the management board will call us to say how much each member has earned, how much we have produced in tons, per hectare … Myself I have been involved in the process of weighing the sugar cane harvested in the field transported in the trucks so I know to process quantity and to the read the reports from the sugar cane company.*

Participant IIMM4: *Today we have workers that irrigate the field and the associations pay them; the workers that harvest the sugar cane are the same. They arrive in the field early in the morning. So this prevents the members of association that are unable to come to do the work or who are sometimes late, compromising the activities in the field.*

Participant IIMM5*: Now we have good revenue compared to when we were working alone.*

The wide assembly also appeared to be an interesting forum that involved active social learning processes and also provided important tools for social learning, as they sought to follow the statutes of the association. This meeting aimed to deliver a report of activities in the irrigation association to the associates from the management board, and to develop a new plan for the next agrarian campaign and as result new emerging contradictions came up that were the subject of new learning. The management board also uses this forum to bring contradictions that happened during a certain period of activities to the table for discussion and deliberation. Most of these contradictions affected the yields, contracts and produced outcomes, and also manifest in conflicts as shown in the data in sections 4.3.1.3 and 4.3.1.4 above.

Table 4.3 presents a summary of the social learning observed in the Macubulane irrigation association. As noted in Chapter Two, social learning has been defined as a change in understanding that goes beyond the individual and spreads within communities or groups through social interaction between people (Cundill et al., 2014; Reed et al., 2010). Table 4.3 presents the changes through a social learning process in irrigation practices as identified via the various data sources used for the construction of this case study.

Table 4.3: Social learning components (i.e. generative mechanisms) identified in Macubulane irrigation association (Framework adapted from Kumler and Lemos, 2008)

Social learning capacities	Data sources						
	Individual association member/peasant	Observation in group practices	Management board	Individual members of management team	Agricane company extension service	CIDAE	Focus group (all together)
Identifying and engaging with contradictions	x	x	x	x	x	x	x
Ability to work/learn together	x	x	x		x	x	x
Understanding of mutual interdependence			x			x	
Trust	x		x				x
Faith in committee abilities			x				
Response to constraints		x	x	x	x	x	x
Ability to introduce new technology	x	x					
Ability to perform new practices	x	x			x		

In summary, the types of learning practices identified in this case study include workplace learning and social learning (see Table 4.4 that follows)

Table 4.4: The types of learning identified in the Macubulane irrigation association

		Mechanisms of learning from which transformation originates		Types of learning
		Workplace learning	Social learning	Bridge for potential transformation
Subject/ object of learning	Empirical	The learning is mainly situated, and takes place by doing Associated challenge: learning by experimentation which requires dealing with uncertainties, single-loop and guarantee that farmers have to practise following the rules of game	Transmission of empirical knowledge in irrigation practices or empirically observed behaviours amongst multiple actors in the irrigation system	Linking to cognitive changes
			Major perspectives: Linking knowledge with action; the community's perspective Associated challenges: Frictions existing between scientists (agents of knowledge) and decision-makers (agents of action). It is not clear how to effectively link knowledge with action and how to link action to knowledge.	Linking to collective social transformation Linking knowledge to action in reflexive and adaptive ways
	Normative	Production of new values, rules, artefacts. Major perspective: Deliberation theory - double-loop learning Associated challenge: Existing values need to be compatible with needs of sustainable practices	Value and worldview diffusion over space and time Major perspective: The advocacy coalition Framework: Cultural evolution Associated challenge: Normative beliefs and values are important drivers of environmental conflicts	Linking to sustainability

Table 4.4 above gives an overview of mechanisms of learning in Macubulane irrigation association in context of workplace learning and social learning and how this is concerned on building transformative social learning. In addition, it identifies types of learning that are to be considered for broader understanding of the transformative social learning in this association.

4.4.3 Who is shaping or influencing the farmers' learning and how?

As can be seen from the sections above, the process of learning in the Macubulane irrigation association is mostly influenced by local institutions, through interactions with the association. I observed that learning occurred through interaction between the activity systems that had been identified in this case study context, and that this included local representation of the Ministry of Agriculture, education institutions, the Incomati Sugar Cane Company, and GAPI. Those institutions provided knowledge to the association, as well as learning resources, and supported the learning of new practices via on-site demonstrations and continued support. However, due to the diversity of the learners' background, they also learned among themselves, i.e. between members of the association.

As explained in section 4.2.3.4 above, the Incomati Sugar Cane Company provided an expert or trainer responsible for technical assistance of the sugar cane production and monitoring the sugar cane activities in the field. The expectation of the Incomati Sugar Cane Company was that farmers are able to solve most of the disturbances at this level, in the workplace. The learning tools and artefacts included working in small groups and demonstration in the fields. Learning was also influenced by facilitators from SIDAE. They taught members of the Macubulane irrigation association to produce other crops, such as maize and vegetables, and also to apply this knowledge outside of the irrigation system, for example, in their homes. This activity from SIDAE resulted from the change laboratory workshop, which is explained in more detail in Chapter Six. The facilitation process in Macubulane is relevant because it guarantees that farmers are able to gain knowledge that ensures high rates of sugar cane yield per hectare. The facilitation process reduces the risk, articulates activities of irrigation, cropping and harvesting, stimulates irrigation learning practices, and solves emerging contradictions.

In summary, I could observe that learning in the Macubulane irrigation association and in relational engagement with other actors occurred as follows:

(i) Learning happened between members of the management committee, while planning and doing resource mobilisation for the irrigation system;
(ii) Learning happened between management committee learners and association member learners through engagement with specific issues that emerged from a certain activity;

(iii) Learning happened in interactions between farmers; as noted in the sections above, the members had different kinds of knowledge that were relevant to the process of irrigation activities, farming and administration.

(iv) Learning happened between members of the irrigation management committee and management of the sugar cane institutions; for example, GAPI has facilitated a course in accounting and savings for the members.

(v) Learning was influenced when actors were involved in activities within an activity system while dealing with contradictions or disturbances. They tried to understand the dissonances with a deeper understanding and reframed new possibilities to overcome that disturbance (see also Chapter Six).

(vi) Learning was influenced in the process of internship and as groups of learners from the Agrarian School, researchers from universities and agricultural institutions interacted with farmers on the issues of irrigation and sugar cane production. Researchers also facilitated learning when they came from different parts of the world to the Macubulane irrigation association to interact with farmers.

4.5 Potential for transformative social learning

In this section I discuss the potentiality and evidence that emerged in the study for transformative social learning in the Macubulane irrigation association. I discuss this from the perspective of learning, cognitive transformation and social change (section 4.5.1); learning transformations through engaging with contradictions (section 4.5.2); transformative learning through building new agency and activity in irrigation systems (section 4.5.4); relevant normative strategies for learning and transformation in the Macubulane irrigation association (section 4.5.5); and reflexivity in and for transformative social learning (section 4.5.6).

4.5.1 Learning, cognitive transformation and social change

As reported on in section 4.4.2 above, the learning process in the Macubulane irrigation association occurred through workplace learning and social learning. This learning happened at different levels as activities in the irrigation system were linked to operation maintenance, crop management, administration, and planning. Through such learning processes, transformation and social change was expected that leads to efficacy and efficiency in the overall irrigation system. Table 4.5 below shows that most change occurred due to learning new practices in the transition from rain-fed farming to irrigation system farming. The table shows that significant changes in Macubulane irrigation association have occurred in the spheres of cognitive, social, and normative changes which can be associated with the learning of the new form of communal irrigation led farming practices, via the processes described above.

Table 4.5: Changes in the Macubulane irrigation association (cognitive, social, and normative)

Types of changes from rain-fed to irrigation system farming	
Type of change	Argument (based on observations from the data)
Cognitive: Observed via improved knowledge of irrigation system practices (technical production practices and management practices); and knowledge of how to make the irrigation system operate effectively (also via relational knowledge (e.g. knowledge of the need to work together)	• Improved knowledge in irrigation farming and technology • Improved knowledge in finances and accounting • Improved knowledge in irrigation administrative practices • Improved desire amongst members to engage in association activities • Improved need to work together as a group • Improved sense that they must face the constraints to guarantee the irrigation functioning • Improved reflexivity to risks, mostly financial and ecological • Improved consciousness of environmental risks, e.g. soil degradation • Improved awareness of the members' mandates as associates • Improved awareness of the object of activity as an association and its implication for productivity • Improved desire to follow learning instruction, because it related directly to sugar cane yields • Improved trust in management board • Improved transparency
Social changes: As observed by improved social contributions and benefits in the community of irrigation farmers, and new social structures set up to support the new type of farming	• Set-up of credit facilities for the community • Installed healthcare facilities • Improved family income • Reduced poverty • Improved farmer cohesion • Acquisition of collective association resources, e.g. tractors, spray machines, and equipment • Families have improved the houses from precarious houses and have replaced these with houses using bricks • Improved support of education for the farmers' relatives • Improved family savings • Improved funding resources for the association; additional loans and sponsors have been offered to the association from the Agricane company, banks and donors
Normative	• Improved norm that supports involvement of members in irrigation activities • Improved norm that supports the achievement of irrigation activities through deliberation and democratic decision making approaches in many cases • Improved norm related to some aspects of ecological sustainability awareness (water quality, soil quality etc.) although the full impact of sugar cane farming on the environment is not debated

4.5.2 Transformation through contradictions

In the Macubulane irrigation association historical contradictions identified in section 4.4.1 became a source of transformative social learning as the associates dealt with historical dissonances to improve or overcome them. This section describes some of these historical contradictions that resulted through a workplace and social learning process in improved thinking, new activities, acquisition of new knowledge, and ensuring the object of the irrigation association (see also Chapter 6).

The Macubulane community developed rain-fed farming, exposing them to ecological risks, such as droughts which in turn impacted on their economic well-being. This resulted in a lack of food and resources for other needs. However, via the process of joint operating of an irrigation system in a community-based irrigation scheme, and shifting to collective irrigation system practices, it appears that there is a reduced risk of farmers being exposed to earlier ecological and associated social risks that were linked to often irregular rainfall cycles. The ecological risks were reduced because they are no longer dependent on rain for farming, and the financial risks were reduced because they now have an outsourcing kind of system, meaning that the sugar cane production has an already guaranteed buyer for their produce, namely the Agricane Company.

As can be seen from the data descriptions in sections 4.3.1.2 to 4.3.1.4 above, through irrigation practices farmers learned how to produce sugar cane, which was new to most members of the association, as well as how to irrigate the crops using new technologies and schedules. As already mentioned in section 4.4.2.1 above, in this process farmers faced constraints (for example, in the process of changing the aspersers during the day) compromising the yields. Because of such constraints, and through a social learning process, they developed the idea of giving loans to members, so that farmers themselves could hire workers from the community. However, some of the members were unable to pay back the loans. This affected the association's capacity to pay for weed control and irrigation system management. So, the association, through a social learning process, learned that it was better to take back the debt from a member after harvesting and give them what was left after subtracting their outstanding loans. As result, the association board learned in the following year to reduce debts of the members, the association accounting was not affected and the production system was less affected. By doing this, the association learned that the yields increased. Moreover, the members of the association felt that they were practising solidarity with the members of the Macubulane community by offering them the opportunity to work. Because they did not have knowledge of irrigation practices, farmers accepted being involved in learning processes and believed that they would improve performance and well-being by doing so. Workplace learning of sugar cane production was facilitated by the sugar cane company and members were exposed to new capabilities, allowing cognitive and social changes that reflect the objective of the irrigation system.

A new credit facility was installed to create capital for the association. This was done because sugar cane takes nine months to grow and it was only possible to harvest once a year, which means that members only received money once a year. This was a problem for the members, as they did not have enough money to support their needs during the full year or until next harvesting. Therefore, the association introduced a new community credit facility by providing loans to farmers so that they could develop alternative activities. This is an exciting example of the emergence of a new activity from earlier contradictions and tensions in an activity system. Now the association gets funding at a certain rate from GAPI and gives this to the members, so they can use it and repay it at a certain rate.

As mentioned before, all farmers used to be paid the same amount of money after the sugar cane was sold to the sugar cane company. This led to a growth of free riders in the irrigation system, who did not put in as much effort into the sugar cane production as some of their fellow members. This is also a relevant contradiction because some farmers did not work appropriately, in terms of hoeing the field and following the irrigation schedule. The implications of this behaviour were that yields were reduced in certain plots resulting in reduced overall profits for the association. The policy of the association stated that the profits were divided equally amongst all members, even those who did not work during the year and had low yields in their plots. Today, the association's solution is to hire and pay seasonal workers to irrigate. Those workers are also involved during the harvesting of the sugar cane and that activity now falls under the responsibility of the association and no longer the individual members. Now, the association board receives money from the sugar cane company, and they then deduct the costs for the seasonal workers from all members. This has helped to improve the productivity and deal with the problem of free riding members.

Another contradiction had to do with the weak participation in terms of members refusing some of the suggestions made by the management board. For example, the management board suggested buying a tractor, but the members refused (as reported on in section 4.3.1.3). The board then decided to buy it at its own risk. In the following sugar cane season, the running costs were reduced and members started to understand the wisdom in the decision. This suggests that members also learned by observing the effective results of decisions. Issues of environmental concerns were mostly solved by the sugar cane company and involved gradual correction of farmers regarding, for example, using technical measures of irrigation to improve soil conditions.

The process of learning for transformation in the Macubulane irrigation association has been much influenced by the exercise of eliminating constraints, or what Bhaskar called 'absences' (see section 2.5.5). As can be seen from the description above of the association engaging in an ongoing process of eliminating constraints or absences, a process has emerged that is leading to the fulfilment of the irrigation association's object.

4.5.3 Building new agency

Lotz-Sisitka and Le Grange (2010) noted that human agency refers to the ability to act in the world and that understanding human agency requires a focus on what people think, value, and do. The process of agency formation was related to the need of farmers to have adequate capabilities to run, for example, the irrigation system effectively. This meant that the farmers had to learn the hardware and software of the irrigation system (as discussed above in sections 4.4.2.1). The starting point of the process of agency formation in the Macubulane irrigation association was the transition from rain-fed farming practices to irrigation farming practices, which entailed the development of the demanded knowledge, artefacts, and rules for the farmers to mediate all processes of irrigation farming and management (which have been described above).

As can be seen from the data shared and discussed above in sections 4.4.2.1, 4.4.2.2, 4.4.3, agency in the Macubulane irrigation association involved the learning of irrigation practices related to sugar cane production to guarantee that farmers were able to produce considerable yields and guarantee cost-recovery of the investment made. The process of the irrigation system management and its functioning was the subject of internal disturbance and the agency was formed while farmers learned the irrigation practices while acting to keep its production and operational efficacy and associated water efficiency by continually transforming the rules, practices, and the mediation artefacts to guarantee higher productivity. As can be seen from the descriptions provided in sections 4.4.2.2 and 4.5.2 above, in the Macubulane irrigation association, farmers learned while reflecting on activities through a monitoring process that offered possibilities to identify constraints and to create capabilities to collectively develop effective solutions.

Engeström (2005) suggests that individual agency could be understood as a move away from a certain frame of action and the undertaking of initiatives to transform it. When a group of people do this and collaboratively form new productive activities in which they engage, there is evidence too of collective transformative agency (Engeström & Sannino, 2010) which in this case was shown in the transition processes that were occurring from rain-fed farming practice to irrigation farming practice. Thus, in case of Macubulane, the agency that was created was related to the move from subsistence practices to commercial practices of farming.

4.5.4 Relevant normative strategies for learning and transformation in the Macubulane irrigation association

Norms and policies for transformative social learning are concerned with the need to increase professional improvements in irrigation system activities to keep the system operational and successful. The development of community-based sugar cane farming associations, as described in Chapter One, included an increase in farmers' productivity by reducing the operational costs, increasing the yield, reducing risk of crops being affected by climate variability changes, and moving from rain-fed subsistence to commercial production, and a shared means of production. This has put the farmers in the global arena of growth. In the association, social learning strategies have led to engaging with normative transformations of improved benefits (health, poverty reduction, improved education) for families of the farmers, improved social benefits and new social structures (e.g. the credit scheme), and environmental normative engagements (with water efficiency and soil degradation management). As noted in Table 4.5 above, however, the wider implications of monoculture cropping and wider environmental impacts of sugar cane production have not been engaged with in this context, since the focus has been on collective beneficiation as a route out of poverty. This had implications for how the concept of sustainable development was interpreted, and also for how education for sustainable development was interpreted in such a context (which I discuss in Chapter Seven).

4.5.5 Reflexivity

Lotz-Sisitka and Le Grange (2010) noted that reflexivity was central to a social learning approach. They argued that there was a need to continually reflect on what had been learned and to take action to improve what was being done as a result of that reflection. Within the irrigation system, reflexivity may mean learning, for example, to disrupt the poverty cycle as has been the case in the Macubulane irrigation association's activity development and transformation. Reflexivity calls for constant transformation in the irrigation system so that (mostly) internal and (probably) external contradictions are inferred and the system continues to be robust. Wals (2009) stated that a reflexive society should be able to lay existing routines, norms and values on the table, but also be able to correct itself when necessary.

Wals (2009) claimed that society was in constant motion and faces challenges for which no ready-made solutions are available. A reflexive society requires citizens who critically review and revise everyday systems. Wals (2009) described risk societies as those in which insecurity and unpredictability stem from unintentional and (partly) unforeseen changes from (eco-) systems. At the localised level of the Macubulane irrigation association, as observed in this study, the risks are related to the following:

(i) Member's behaviours that can directly affect productivity. An example is the unexpected behaviour of free riders within the association, with whom the management board had to deal.
(ii) Risks related to production. For example, the behaviour of some of the members directly affected the production. Some members failed to irrigate fields or pay their debts and, thereby compromised the accountability of the irrigation association. To overcome this situation, the association decided to own thirteen plots and the gains from those plots were used to support association activities or to cover part of the running cost of the system.
(iii) Risks related to foreseen soil degradation due to intensive sugar cane production. This point is further discussed in Chapter Six, and relates also to the points made above in section 4.5.4 about wider notions of sustainable development and risk.

4.6 Synthesis

In this chapter, critical realism allowed me describe the empirical and actual dynamics in the Macubulane irrigation association through identification and analysis of the dynamics of activity systems. The chapter identified and described the dialectical contradictions within and between the activity systems which, as explained, provided potential for expansive learning and transformation in the irrigation system. As explained, learning in the Macubulane irrigation association occurred through workplace learning and social learning, which led to the creation of new agency and capabilities that sustain the system by ensuring good yields and continuously improved management practices and social status. For this reason, I identified this learning as transformative social learning. Workplace learning operates through formal instruction on irrigation, operation, maintenance, and crop management, while social learning occurs through constraints that the association faces while practicing the new knowledge, introducing new technology, and in the process of administration and planning of irrigation actives. Some of the identified contradictions within and between the activity systems are still subject to further analysis in the change laboratory workshop, which is discussed in more detail in Chapter Six.

CHAPTER FIVE

Case Study Two: Learning in the Massaca Irrigation Association

5.1 Introduction

This chapter aims to examine how and what kind of transformative social learning has (or has not) emerged in existing activity systems to date in the Massaca irrigation association. The chapter follows a similar analytical and reporting structure to that used in Chapter Four. It begins with an explanation of the activity systems and dynamics of the association in section 5.2. It further identifies and analyses the contradictions in and between those activity systems in section 5.3. In section 5.4, I report on the learning of changed agricultural practices as these relate to the new irrigation schemes. Next I describe the influences on the farmers' learning and practice in section 5.5. Finally, I explain the potential for transformative social learning in the Massaca association in section 5.6.

5.2 Activity systems and dynamics in the Massaca irrigation association

5.2.1 Introduction

The concept of activity system was discussed in Chapter Four (section 4.2), where I described the framework for analysis of activity systems. As described in section 4.3.1, in order to understand learning as a phenomenon, it is necessary to understand the activity system in which it occurs as that system (including its goals, beliefs and processes) affects what is learned and how learning occurs. The Massaca irrigation association is comprised of four interacting activities systems: (i) community activity system, (ii) management board activity system, (iii) the educator's activity system, and (iv) the seller's activity system. Each activity system can be characterised by its subjects, the division of labour, the artefacts and tools it employs, its rules, the community, and the object of activity. These four activity systems are described in the following sections.

5.2.2 Community activity system

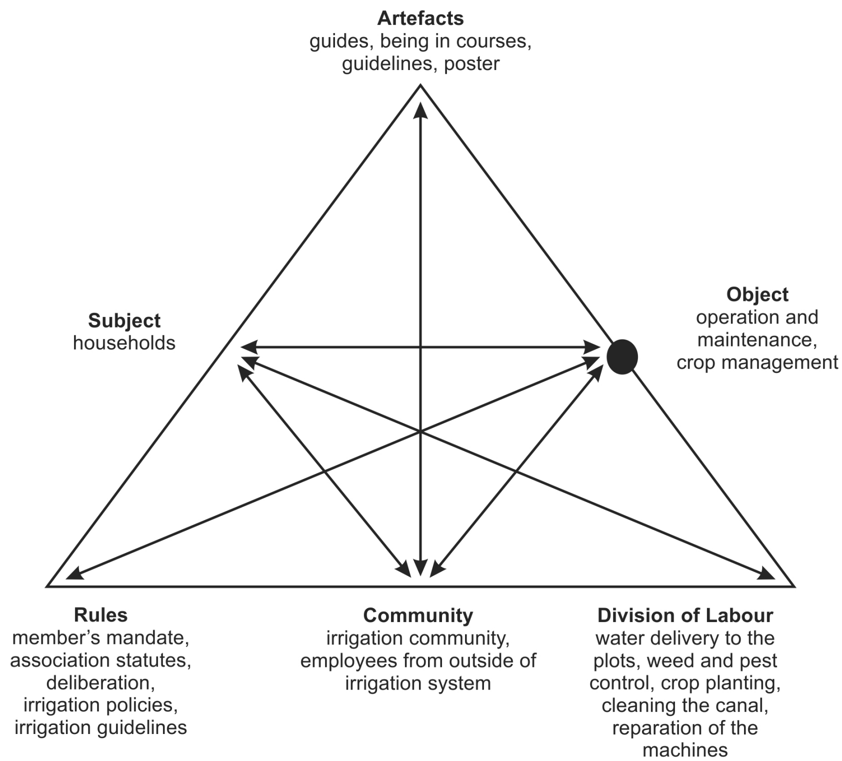

Figure 5.1: Representation of the community activity system

The subjects in this activity system are the members of the irrigation association. In this group, there are those who only practise farming and those who, besides farming, also practise activities such as teaching, mechanics, commerce and building of houses. The object of this activity system includes water delivery, crop management, and operation and maintenance of the system. In terms of division of labour, there is one person responsible for operating the pumping station, and the water delivery to canals and plots. If the pump machine breaks down, depending on the seriousness of the problem, a service company is asked to repair the system. However, at the time of the research, the system was considered to be obsolete; only two of the five pump machines were operating and the irrigation infrastructure was delivering water below capacity to the whole irrigation area. Due to the fact that machines were not working and their replacement is expensive, a new schedule was developed for water supply (only once in three days). However, because the pumping capacity is lower, some of those at the perimeters do not get water at all. The community maintains the canals within the perimeters and the management board expects all farmers to participate in this process, as was agreed upon. The community is also responsible for cropping management. A tractor is hired to clean the plots, and then each farmer is responsible for planting, weed control and harvesting. In some plots the farmers practise organic production of crops.

The workers on the plots might be the members of the association, but in some cases, they are not. Some members hire outside farmers and pay them for their work. This has implications for who is learning irrigation practices in the system. I found that in some cases it was members that were involved in this learning, but in other cases the learners were not members of the association.

In terms of artefacts and tools, community knowledge partly results from involvement in courses organised by extensionists from the Centre for Integration and Agribusiness Development (CIDAE). The courses are offered in the context of the *School in Farmers Field* programme, in which the organisation supports the community by providing irrigation farming tools and helps them to implement new technologies. Some members also train others members of the community and supervise the process of planting and weed control. Some community members have participated in a course on the use of dolomite (i.e. pig manure) to promote organic agriculture. The community also uses knowledge from their parents. The *School in Farmers Field* programme is promoted in the fields of the farmers, providing the farmers with knowledge in crop production.

The rules in this activity system are derived from the statutes that describe the mandate of the members and their rights. Available rules include agreed water fees, a water supply schedule, and instructions, guidelines and directions from the general assembly. There are a range of national policies that outline the need to shift towards commercial farming through irrigation. This includes the need to create capacity and develop the appropriate farming technologies, as described in Chapter One (section 1.3.3). There are, however, no formal criteria to evaluate the maintenance of farming activities. The irrigation management board simply follows the activities of the farmers in the field, as shown in the extract below.

Data extract from an interview with farmers (June 2012)

Researcher: What are the activities which are being done in irrigation system?

Respondent IIMM1: *The association does maintenance, each member does maintenance of the channels on his/her plot, and sometime we join together to clean the main channels or those that are blocked.*

Researcher: When did you start irrigation activities?

Respondent IIMB3*: I started working here in 1997, before I was doing rain-fed farming in Massiquiri, and I used to produce pumpkin leaves, which we used to eat and is prepared with peanut sauce.*

Researcher: How did you learn irrigation practices?

Respondent IIMB3: *I learned irrigation from the training course 'School in Farmers Field'. I learned how to crop, prepare the land, how and where to put seeds for example, how to plant maize, cucumber, beans, and we plant beans after maize …We were given documents for us to read and learn.*

5.2.3 Educators' activity system

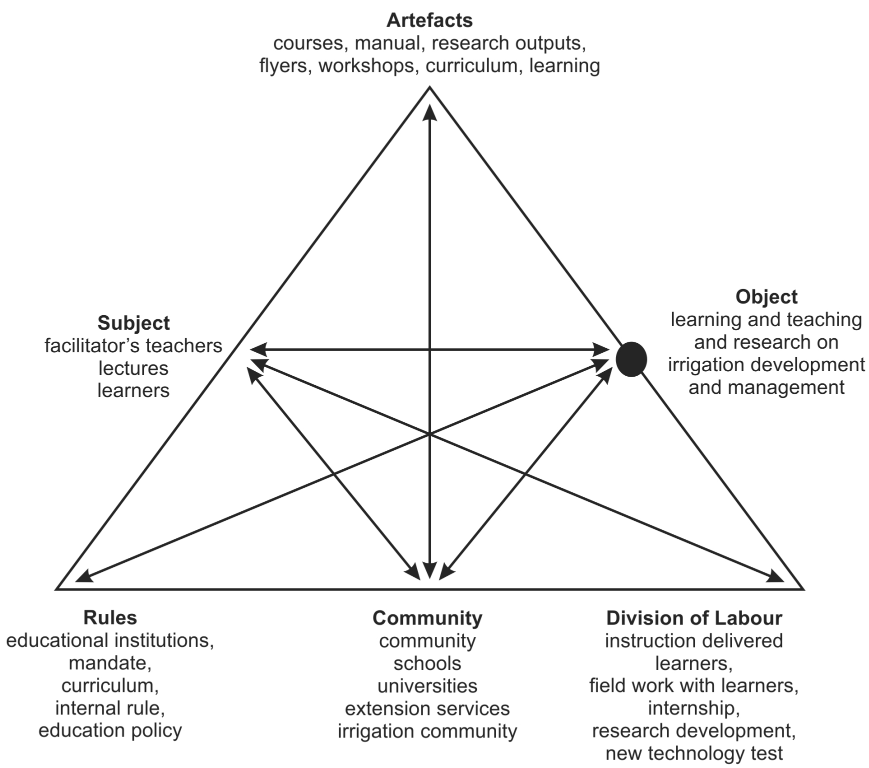

Figure 5.2: Representation of educator's activity system

The subject of the educator's activity system includes teachers, facilitators and learners. Institutions involved include agrarian institutes and schools, CIDAE, Higher Education Institutions (HEI), and agro-agencies. The intended outcome is that farmers have knowledge of irrigation practices and management. The object of the system is to teach or facilitate learning in irrigation practices and management, including research on issues related to irrigation management. The institutions involved, such as the agrarian schools and institutes, are responsible for training the learners in the agrarian field. Most of the learners become incorporated in the CIDAE (local agriculture representative) and become extensionists to work in the irrigation fields. The HEIs undertake research and teaching in agrarian and environmental fields related to education, irrigation, agrarian studies, engineering, and environmental studies.

The division of labour includes teaching, facilitation and training, curriculum development, irrigation policy and strategies development, and agrarian technology development and implementation. The HEIs conduct research, and develop curriculum related to the referred field and community services. The outcomes include improved knowledge in irrigation practices, improved farming technology, and increased irrigation capacity of learners. The artefacts include available curriculum in the subject of irrigation, crop management, water engineering and environmental studies, training courses offered to irrigation associates (see Table 5.1), ordinary meetings in the association, and meetings with relevant stakeholders. Most of the members in the irrigation system do not have formal instruction on irrigation. Some of the available materials were developed by CIDAE, such as the file from *School on the Farmers Farm Training.* The facilitators use demonstrations in the field to show farmers how to farm and irrigate the field to produce higher yields. HEIs offer a range of syllabi, manuals, and books. In summary, the tools available in this educators' activity system include courses, training, workshops, meetings, manuals, research outputs, flyers, curriculum, learning tasks, handbooks, and guidelines. The rules include the association's statutes, which contain a mandate of the members to be involved in increasing capacity, mandates from educational institutions, educational policy, irrigation policy, agrarian policies, and strategies, as described in Chapter One (section 1.3.3). Irrigation systems are the subject of internship programmes creating space for learners to interact with the farming practices and technologies.

Table 5.1: Courses or learning programmes offered to producers in the irrigation association

- The *School in the Farmer Field* facilitated by local extension services.
- Courses meant to introduce new tools of agrarian practices to the producers.
- Course on how to make a compass of seeding in the field, developed by the Ministry of Technology.
- Institutional researchers visited the Massaca irrigation association to share experiences between farmers on, for example, biological agriculture.

The extract below illustrates the farmers' activities in the irrigation scheme.

Data extract from an interview with farmers (June 2012)

Researcher: What are your activities in this irrigation scheme?

Respondent IIMB2*: I have been here for the last two years, I and do technical follow up of the producers, I disseminate adequate farming technics to the producers, I evaluate the income of the land cultivated, I create meetings with producers, where we discuss some issues such as technologies…*

Researcher: How did you learn about irrigation practices?

Respondent IIMB1*: We had a training course on seeding compass, delivered from Boane District Directorate, I also went to Technology Ministry here in Boane District, where we learned how to produce tomatoes and cucumbers. We also had a course from Ministry of Natural Resources, where we learned how to use some minerals for farming... A team of teachers and students used to come to this irrigation system; sometimes they discussed with us how we were cropping.*

Respondent IIMB5*: There is an extensionist from CIDAE, he used to come to teach irrigation and cropping and come to see how are we doing things.*

Participant FGMB5: *I'm vice-president of the association. I went to a course and I am responsible for implementing this programme here in this association. I help farmers with cropping and irrigation, I come to see how they are planting, I do meetings with them.*

5.2.4 Management Irrigation Committee activity system

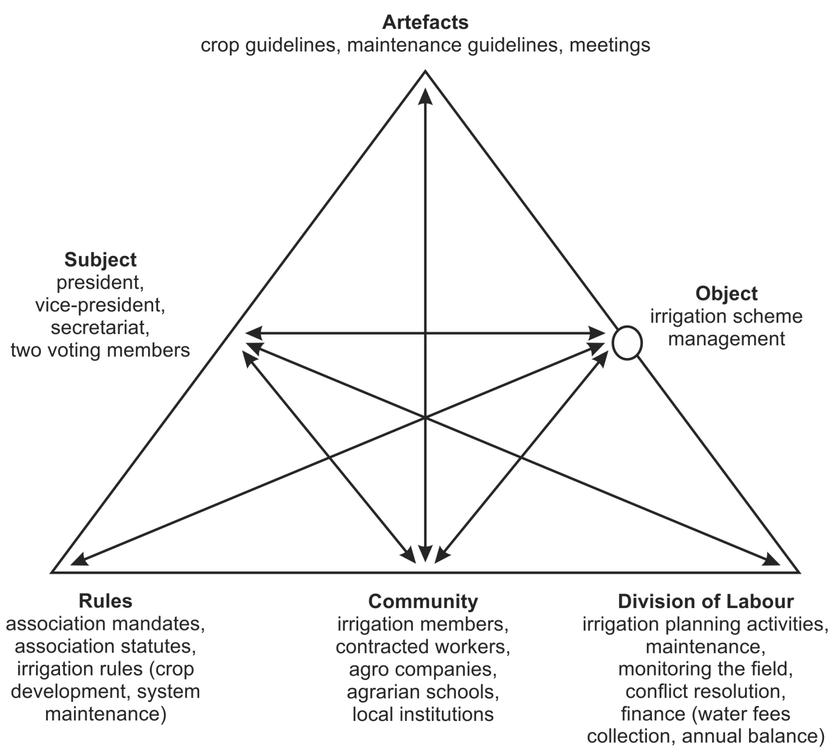

Figure 5.3: Representation of the management irrigation committee activity system

The subject of the Management Irrigation Committee activity system includes the association president, vice-president, an accountant, and voting members.

The object of the management committee is to ensure the implementation of a wide range of deliberations on what was discussed and approved in the meeting, elaborate on and provide accounts and accounting reports, collect water fees, and guarantee the implementation of the association's statutes.

Outcomes include improved irrigation performance and sustainability of the irrigation system.

The tools in this system include meetings, manuals, training courses, irrigation guidelines, and guidelines for cropping. The board meets regularly, also with the ordinary assembly, which includes the whole community. The agenda is to discuss constraints in running the association, and to inform the implementation of deliberations on a wide range of issues from the wider assembly, and specifics from the management committee.

The division of labour includes the planning of activities on irrigation, operation and maintenance, monitoring of the field, conflict resolution, water fees collection, and accounting. The rules are the association's statutes, production plans, irrigation policies and strategies, as illustrated in the extract that follows.

> **Data extract from an interview with the Head of Irrigation Massaca irrigation association (9 June 2012), focussing on management practices in the irrigation system**
>
> **Researcher:** How do you manage the irrigation system?
>
> **Respondent IIMB1***: We have to pay electricity, we use an electric water pump, we charge water bills and with that money we pay electricity and water bills … We also do the maintenance of the channels as well as the electric water pump machines, we do this ourselves. We have statutes ... The association is constituted of the president, vice-president and three voting members and wide range assembly. We have 189 members and each have a plot less than a hectare, each is responsible for his/her plot.*
>
> **Researcher:** How are farmers getting involved in the management of irrigation system?
>
> **Respondent IIMB1***: Members give us ideas, and from that we do judgment what is valuable… we meet on the weekend or when there is an emergency … we work with local leaders and with the extensionist*.

5.2.5 Sellers' activity system

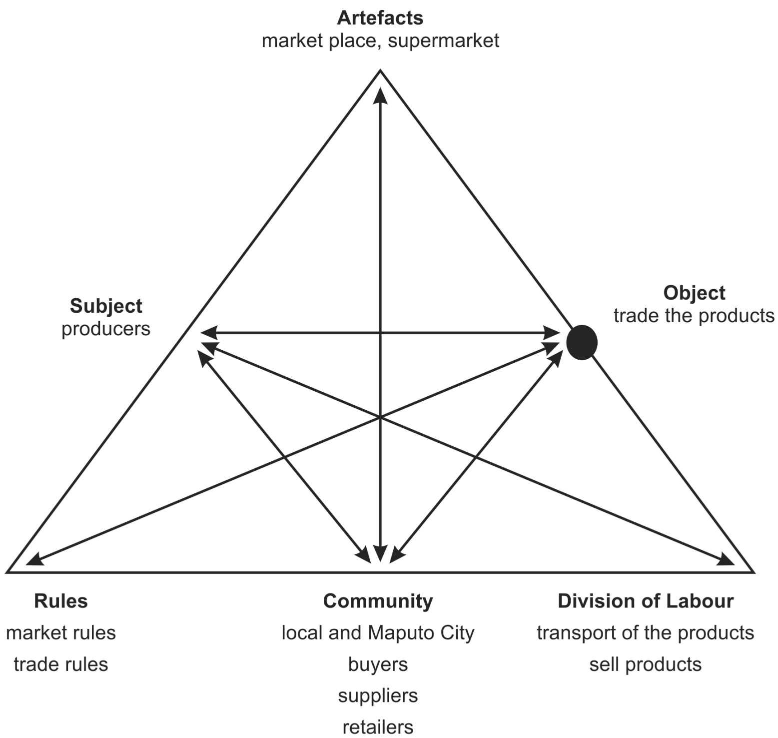

Figure 5.4: Representation of sellers' activity system

The *s*ubject of this system is the sellers. Sellers are mainly farmers and re-sellers from outside the association. The object is to trade farmers' products. The artefacts in this system are the markets and supermarkets in which the produce is sold. The farmers sell the products on the main road nearby the irrigation system, and some travel to the main market in Maputo city. The division of labour in this system includes supplying and selling of farm products in the irrigation system, in the village, and in the markets and supermarkets of Maputo city. The rules of this activity system are market and trade policies and general rules that govern trade in the monetary economy. The community includes buyers, supermarkets, suppliers and re-sellers. The data below illustrates these aspects.

Data extract from an interview with farmers (June 2012)

Researcher: Where do you sell your products and who are the buyers?

Respondent IIMB1*: We used to have a contract with Shoprite, they used to buy our products.*

Respondent IIMB2: *We sell our products here, outside the irrigation system.*

Respondent IIMB4: *I don't practise other activities apart from farming ... I sell the products in the market Fajardo in Maputo city and I have good profit mainly during the winter because we can't produce then with rain-fed farming only with irrigation.*

5.2.6 Shared object

As I mentioned in section 4.2.1 it is important to note that of central significance in Cultural Historical Activity Theory is the distinction between actions of individuals and collective object-oriented activity within this system. Actions are understood in relation to object and motive of an activity system. The object of an activity system is transformed, both in conversation and materially (e.g. in the artefacts) into outcomes or products. Collective activity is driven by a communal motive, which is embedded in the object and object is constantly transformed by individuals involved in the activity over time.

Figure 5.5 presents a graphic of the shared object as it is proposed by CHAT theorists, and found in the irrigation system under investigation in this study.

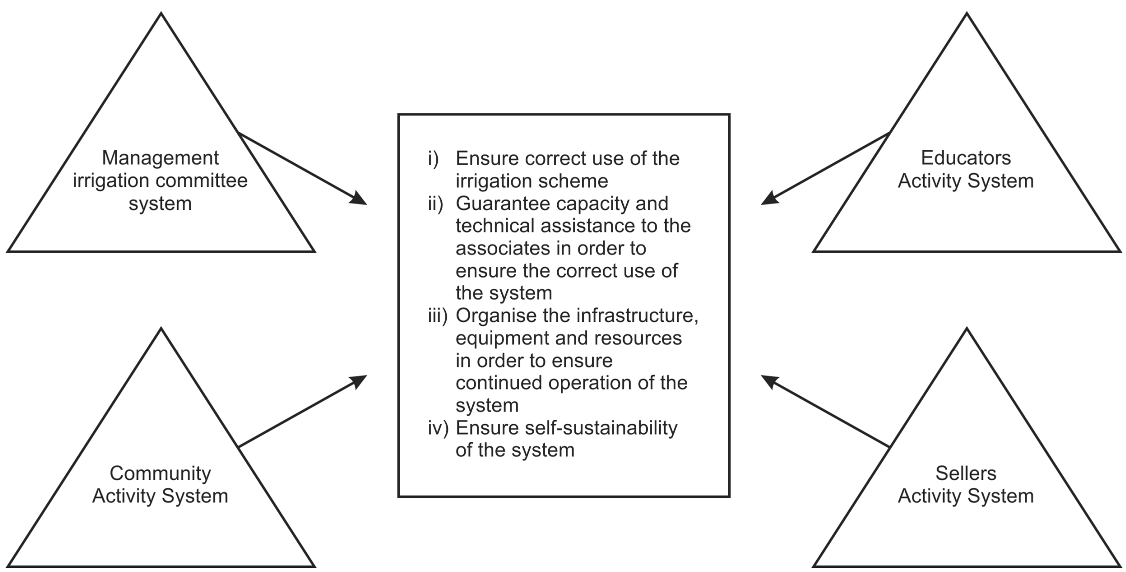

Figure 5.5: Shared object in Massaca

Understanding the cultural historical dynamics of activity systems, and how they interface around a shared object both within individual activity systems and between the interacting activity systems, provides a means of analysing learning and transformation and the contexts of learning as well as the conditions in which learning emerges and occurs as explained also in Chapter Four (section 4.2.1). This involves reflecting on the activities in workplaces and emerging contradictions, as also described in Chapter Four (section 4.3.1). It is important to note here that the main actors in the irrigation system are mapped and considered in the identification of the interacting activity sytems. If 'outsider' or new activity system influences are detected, then these are considered as part of the interacting systems. Throughout the interactions process, sense making happens when (i) activity systems are co-defined with participants in the activity systems and where contradictions are identified, shared and further assumed in irrigation association, and (ii) when contradictions are engaged at different levels and farmers look for and co-define potential solutions.

5.3 Contradictions emerging within and between the activity systems in Massaca

This section discusses the contradictions that were identified between the activity systems of the Massaca irrigation association. The analysis adapted the Uden (2007) framework for analysis of contradictions, as described in section 4.2.2. Within the irrigation scheme, contradictions were identified through document analysis, a series of individual interviews, and a focus group. All these were recorded using video and through field observations and notes. The contradictions were categorised according to primary, secondary, tertiary, and quaternary contradictions, as suggested by Engeström (1987) and described in section 4.3.1.

5.3.1 Primary contradictions

Primary contradictions occur within a single node of an activity system. The following primary contradictions were identified in the Massaca irrigation association:

***Contradiction in the object node of the community activity system (CAS) between traditional and new practices**.* This contradiction became evident in several ways, especially via observations that some members continue to apply the traditional farming practices in the field, instead of applying the newly gained knowledge on irrigation practices. This contradiction manifested in different ways:

- Farmers do not apply the adequate quantity of seeds that should be used during plantation under irrigation; therefore, the outcome is not according to expectation.
- Farmers still practise cassava production in the irrigation system. Cassava plants do not require much water and take nine months to grow. Cassava is not often irrigated and are more commonly rain-fed.
- There is a high rate of loss of water when water is fed to plots that are not in use according to an outdated irrigation schedule (unsustainable practices).
- Farmers themselves sell products in the market in Maputo city; however, sometimes they have too much, and the products get detoured.

The data extract below illustrates these points.

> **Data extract from an interview with farmers (June 2012)**
>
> **Researcher**: Are all farmers working in irrigation system?
>
> **Respondent IIMB1*:** *There are plots that are abandoned – farmers do not come to produce and we use the gravity method of irrigation, and sometimes we let out water and in a certain area we find that there are very few plots that are being used, so water is not used.*
>
> **Researcher**: Can you sell all the products and get revenue?
>
> **Respondent IIMB4*:** *Sometimes we get good profit but there are times that we go to the market and we find that there is are a lot of tomatoes and we cannot sell and they get rotten – we throw them away and lose.*

Contradiction in the mediating tools node in the CAS and also in the management board activity system (MBAS) between prior experience and irrigation concepts. Most of the associates did not have formal instruction on irrigation. When the board committee was asked about the meaning of irrigation management, there were diverse understandings, and in general, a poor understanding of the holistic approach of irrigation management. They have a basic knowledge of farming from their relatives, mostly in rain-fed agriculture practices, but they have a poor understanding of the meaning of irrigation management. Interview data showed that there is a lack of understanding principles of irrigation such as irrigation efficiency, cost recovery (i.e. irrigation costs against outcome). It became clear from the interviews with the farmers that they did not attend any courses on integrated irrigation management involving the community. This means a scarcity of courses, specifically in irrigation management involving communities, as shown in the extract below.

> **Data extract from an interview with the field instructor (7 February 2013), focussing on learning practices in the irrigation system**
>
> **Researcher:** Do the farmers do what you teach? Where did you learn irrigation practices and what is irrigation management?
>
> **Participant FGMB1*:*** *I learned here with extensionist… irrigation management is to put water in the soil.*

Contradiction in the rule node between rules related to plot allocation and water rights fees. This contradiction in the irrigation system can be found in the plots that are abandoned for different reasons. The point is if members pay the water fees according to the rules, the plot is guaranteed even if the member is not using it. When I asked how many plots are effectively being used I was told 170 out of 200 plots. Whereas in fact, this was in respect to the number of people that are paying the water fees. In practice, less that 40% of the plots were in use during the research period. When members do not use their plots, invasive plants enter their plots, including some invertebrates, and this also affects the neighbouring plots. Unused plots also cause wastage of water that is supplied to the perimeter and power that used to supply that water. This contradiction also became evident via the lack of clarity in terms of what criteria were used to determine the cost of water fees. The main problem that was expressed, as shown in the extracts below, was that the prices being charged from the members are insufficient to cover overall running costs of the system, e.g. electricity, water and maintenance costs.

> **Data extract from an interview with the Head of Irrigation Massaca association (9 June 2012), focussing on management practices in the irrigation system**
>
> **Researcher**: How much did you charge for water bill?
>
> **Respondent IIMB1***: We charge 500 Mt per member but we want to increase this because we can't pay water bills with that money. We are going to suggest this in the next wide range meeting; however many do not like it when we talk about increasing the costs of water.*
>
> **Data extract*: Massaca irrigation association, focus group interview (7 February 2013) with association management committee, farmers, SIDAE, Agrarian Institute***
>
> **Researcher**: Why are there are plots that are not being used?
>
> **Participant FGMB1***: Because native farmers they give their plots to others when they cannot pay fees, and those who come sometimes pay the bills but do not cultivate … they are still members and we cannot do anything.*

Contradiction in the tools nodes of educator's activity system* (ESA) *between knowledge needed and knowledge provided in the college curricula. This contradiction was shown in an analysis of the curriculum of the Agrarian School in Boane District and tertiary schools in the area, which indicated that there was no agricultural education in the educational curricula or in the curricula for training teachers and there were no syllabi providing for training of farmers in community based irrigation activities (see extract bleow). Yet these were new practices with new expectations, as national policy requires farmers to co-operatively implement irrigation-based farming methods as explained earlier.

> **Data extract from an interview with the Head of Irrigation, Massaca association (9 June 2012), focussing on management practices in the irrigation system**
>
> **Researcher**: Did you had a course on Community Irrigation Management at your Institute?
>
> **Respondent FGMB2***: No I did not, I had a subject on irrigation only.*

Contradiction in division of labour in the managers' roles and practices: It became clear from the interviews that the managers are not present full-time in the system; they only go to the office when there is something to solve, as shown in the extract below

> **Data extract from an interview with the Head of Irrigation, Massaca association (9 June 2012), focussing on management practices in the irrigation system**
>
> **Researcher**: As head of association, how do you work?
>
> **Respondent IIMB1***: I come here when there is something to resolve, sometimes clashes among farmers… I do other activities like apiculture ... however it is difficult.*

Contradiction in the rules node between informal and formal agreements: This contradiction became evident as the management board organises with companies to provide certain services with formal agreements, but at times provides farming products without a contract. Farmers do not know how to elaborate on contracts, or how to make contracts or even how to interpret them, as illustrated in the data below.

> **Data extract from an interview with the Head of Irrigation, Massaca association (9 June 2012), focussing on management practices in the irrigation system**
>
> **Researcher***:* Do you have a contract with those companies?
>
> **Respondent IIMB1***: We have agreements with those companies to sell products.*
>
> **Researcher**: Do you know how to elaborate contracts?
>
> **Respondent IIMB1:** *We haven't learned to do the contracts and we don't know…*

5.3.2 Secondary contradictions

The following secondary contradictions occurred between nodes in the activity systems.

Contradiction between rule and object nodes: This contradiction was evident as some of the perimeters do not get enough water for longer periods. As a result, some of the plots become dry allowing the growth of invasive plants that kill crops or reduce the yield per area. Those plants also spread to neighbouring plots and affect the productivity (see Figure 5.6).

Figure 5.6: Observable disturbances due to inadequate weed management. Invasive plants compete with the crops and affect production

Contradiction between rules, object and division of labour: This contradiction became evident as the members still have a limited understanding of the concept of association and what it means to be part of an association, how to work with irrigation systems, the concept of irrigation management, and their obligations prescribed in the statutes/mandate of the irrigation association. This is evident in the following data extract:

> **Data extract from an interview with the Head of Irrigation, Massaca association (9 June 2012), focussing on management practices in the irrigation system**
>
> **Researcher**: What do the members do here?
>
> **Respondent IIMB1*:*** *We are associates by land, each member works in his plot, produces and sell his products, in his own way, and the condition to be a member is to be resident here and pay the duties … Not all members know the statutes of irrigation…*

Contradiction between object and division of labour*:* This contradiction manifested in water shortages that are related to a lack of maintenance, as broken tubes are not replaced and taps are demolished, as described in the extracts below.

> **Data extract from an interview with the Head of Irrigation, Massaca association (9 June 2012), focussing on management practices in the irrigation system**
>
> **Researcher:** What are the main issues in this association?

Respondent IIMB1: *The main issues are that the electric pumping machines are obsolete, they get broken often so we cannot now supply water … now out of five, only three pumping machines are working.*

Data extract from an interview with farmers June 2012

Respondent IIMB3*:* *There is a water shortage, the machines are broken, and now we can irrigate only once per week.*

Figure 5.7 that follows shows further evidence of this contradiction as it depicts disturbances related to poor maintenance and water supply to the field, which in turn affects crop production.

Figure 5.7: Observable disturbances related with poor maintenance and water supply to the field, affecting crop production

Contradiction between rules and subject: This contradiction manifests due to a lack of water in the plots, as some members do not pay for water and the irrigation committee has problems paying the energy bills as seen in the following extract.

Data extract from an interview with the Head of Irrigation, Massaca association (9 June 2012), focussing on management practices in the irrigation system

Researcher: What are the issues in irrigation system?

Respondent IIMB1*:* *We have problems – members do not pay water bills and we have problems to pay water and electricity … we have debts now.*

Contradiction between the object, the rules and division of labour: This contradiction becomes evident in the finding that the organisational structure of the irrigation system seems inadequate to allow for all activities needed to run the system, as explained in the following data extracts.

> **Data extract from an interview with the Head of Irrigation, Massaca association (9 June 2012), focussing on management practices in the irrigation system**
>
> **Researcher:** What are the duties of the farmers?
>
> **Respondent IIMB1*:*** *As president of association I do management of irrigation, financing management. I'm not a worker here … I come when needed.*
>
> **Researcher:** What are the duties of the farmers?
>
> **Respondent IIMB1***: Farmers must pay water bills and dues but in most case farmers do not accomplish their duties, because they have to pay water bills and dues ... and sometimes they have their reasons.*

Contradiction between the rule, object, and division of labour node of community activity system manifests as follows. Due to a shortage of water, some households close the water in the channels and then the next plots are unable to get water. This has immediate effects on crop development and becomes a source of conflict between and within households as shown in the following data extracts.

> **Data extract from an interview, focus group Massaca irrigation association (7 February 2013), focussing on management practices in the irrigation system**
>
> **Researcher**: What are the most conflicting issues in this association?
>
> **Participant FGMB4*:*** *The most conflict is probably the water dispute. We have problems with water – it does not reach all members and each member tries to get water for himself, by closing the channel and diverting to his plot, so we have problems among farmers.*

Contradiction between the rule and mediating artefact nodes, which becomes evident as many households do not attend the meetings and argue that they do not receive water in their plot and they cannot produce accordingly as shown in the data extract that follows.

> **Data extract from a focus group interview (7 February 2013) with farmers, management board and CIDAE**
>
> **Researcher:** Why do farmers who do not pay attend the meetings?
>
> **Participant FGMB5*:*** *Some farmers do not go to the meeting because they ask 'why should we have come to the meetings, if we don't receive water and we cannot irrigate the land and the management board do not solve the problem…'*

5.3.3 Tertiary contradictions

Tertiary contradictions can be found when an activity is remodelled to take new motives or ways of working into account (see also section 4.3.1.4). Thus, they occur between an existing activity and what is described as a more advanced form of that activity. The following tertiary contradictions emerged from the analysis in the Massaca irrigation association context.

Contradiction between community's activity system object and management board activity system rules which manifests as some members do not pay the water bill and, according to the association's rules, if someone does not pay they are fined and the association can confiscate the plot. The management board confiscates that plot and offers it to another outside person or association member. However, this does not mean the next owner of the plot necessarily pays the fees and, if they are able to pay, they often do not know how to effectively use the plot with irrigation. The association continues to find members that are not paying, resulting in unused plots as shown in this data extract:

> **Data extract from a focus group interview (7 February 2013) with farmers, management board and CIDAE**
>
> **Researcher**: What do you do if farmers do not pay the bills and dues?
>
> **Participant FGMB1***: When the farmers do not pay the bills, we take the plot and give it to another interested person.*

Contradiction between community subjects' knowledge and experience and educators' activity system mediating tools, in which some members continue to refuse to apply the knowledge on modern farming technologies provided by extension officers, is shown in this data extract:

> **Data extract from an interview with the field instructor (7 February 2013), focussing on learning practices in the irrigation system**
>
> **Participant FGMB2**: *Farmers do not always follow all I say, some learn … others don't. They say that they already know everything; they say that I'm still young, and they started long time to practise agriculture…. They have learned before I was born... I also have seen plots that have not been hoed properly, some do not follow the seeding compass. Others put a lot of seeds in the hole when they are planting and say that not all will grow and as a result, plants do not grow well and we don't get good results in this case … But those who follow me, they get very good results.*

Contradiction between community object and management board activity system rules manifests as some household plot workers are not the owners of the plots. The implication is that the owners do not participate in the meetings; they send their workers who are not able to properly answer the issues related to the rules and governance of the irrigation scheme as per the needs of the management board's statutes. This is shown in the following data extract:

Data extract from an interview with the Head of Irrigation, Massaca association (9 June 2012), focussing on management practices in the irrigation system

Researcher: What is the level of participation in the meetings including the wide range assembly?

Respondent IIMB1: *The level of participation is very low: 25% of members are from the city and most time they only have land but they are not in the association. When we have meetings they send their workers and that does not work, because the workers do not tell owners correctly what we have discussed.*

Contradiction between the management board activity system rules and community activity system object – some members do not pay water fees, yet are using the plots and water, and they build up a large debt. As a result of a deficit in water collection bills, the management board fails to pay invoices, including to cover the running costs of the system. This problem is associated with the lack of systematic maintenance and the overall irrigation infrastructure is becoming obsolete as also shown in the extract below and Figure 5.7.

Data extract from an interview with the Head of Irrigation, Massaca association (9 June 2012), focussing on management practices in the irrigation system

Respondent IIMB1: *Some farmers receive water but they don't pay water fees for irrigation system – we don't know why? And these problems make us go back again, because we start to have debts with the electricity company again.*

5.3.4 Quaternary contradiction

Quaternary contradictions are those occurring between different co-existing or concurrent activities (objects) as also described in Chapter Four (section 4.3.1.5). The following quaternary contradictions were identified in the Massaca irrigation association context:

Contradiction between irrigation farming and co-existing farming activity objects: Evidence in the study showed that members also have plots outside of the irrigation schemes on which they practise rain-fed agriculture, mostly growing cassava and maize, during the rainy season from October to February. In the same period, they plant the same crops in the irrigation system. This has implications for the outcomes during the year, as the market can be flooded with particular products. The market prices sometimes change depending on the availability of the products. What happens is that the members develop the same production plan; they may decide to produce maize or beans in a particular season. During the harvesting, they find that the market is flooded with that particular product. So, the prices decrease and the members sell the products for less than they could otherwise, and sometimes do not even recover the costs. This was evident in the following data extract:

> ***Data extract from a focus group interview (7 February 2013) with farmers, management board and CIDAE***
>
> **Researcher**: Do you work only in the irrigation system?
>
> **Participant FGMB3:** *I work here and I also have another place where I do rain-fed agriculture. I have maize, beans and cassava; when it starts raining, I go there… I do that because sometimes there is no water.*

Contradiction between the management board, community, sellers and selling and delivery activity objects: This became evident from data that showed that the irrigation management committee had a contract with a company and supermarket in Maputo to supply farming products on a daily basis. However, they faced a challenge, because they were supposed to provide themselves with transport to deliver to the supermarket. Because the transport was quite expensive they lost that opportunity. And because farmers used different production plans they were unable to guarantee sufficient quantity of farming products on a regular basis. This was evident in the following data extract.

> **Data extract from an interview with the Head of Irrigation, Massaca association (9 June 2012), focussing on management practices in the irrigation system**
>
> **Researcher**: What kind of agreements does the association have?
>
> **Respondent IIMB1***: We had a contract with a supermarket in Maputo City, however they wanted products every day, we asked for transport and they said that transport is our responsibility … now we have problems with how to take products to Maputo, we don't have the capacity to hire transport every day, and we are not able always to fulfil the list and quantity of products that they need; sometimes farmers do not have enough.*

From this it is apparent that the major contradiction between the irrigation system object and the community objects for food production are intimately linked to the need for transitioning from existing rain-fed agricultural practices, to market-oriented, irrigation system driven production practices. As can be seen from the discussion above, much of this was related to prior knowledge, experience, the difficulty in changing existing cultures of practice, and complexities associated with resources and technology based capabilities. Many of these can potentially be addressed via expansive learning processes. The next section discusses the learning associated with changing agricultural practices as this relates to the introduction of the new community-based irrigation schemes in Massaca.

5.4 Learning of changed agricultural practices related to the new irrigation schemes

This section explores how farmers have been learning changed agricultural practices related to the new irrigation schemes. I begin in section 5.4.1 by sharing understandings on motivation for learning irrigation farming. Next I discuss the learning processes in section 5.4.2.

5.4.1 Motivation for learning irrigation farming

In Chapter Four (section 4.4.1) I have explained understandings of motivation. The motivation in the Massaca irrigation association was largely related to the sense of security that farmers feel, i.e. that they always receive water, and from this increase productivity. This is related to their need to improve social conditions and productivity, and reflects in a concern for the irrigation facilities. They believed that they would achieve this through learning irrigation practices and joining the association as shown below in the data extract from a group interview with farmers.

> **Data Extract: Massaca irrigation association, group interview with farmers, 9 June 2012**
>
> **Researcher**: Why did you join the irrigation association?
>
> **Respondent IIMB5**: *It is good here because even if it's not raining, we always produce. When it is hot, we usually lose almost everything we have produced in the rain-fed plots outside of the irrigation system, but in the irrigation system, I can irrigate and produce and have food to feed my family, pay my children's school, and I produce maize, tomato, beans, cabbage, and garlic.*
>
> ***Respondent IIMB3***: *First I was doing rain-fed farming, however I have met friends that were already working in irrigation and they explained to me how they had been working and told me that they were getting good revenue and then I decided to join the irrigation farming.*
>
> **Respondent IIMB3**: *I sell at the Fajardo market, however, when we have too much product then it gets detoured.*
>
> **Respondent IIMB5:** *Here is better because even when there is no rain, I can still farm.*
>
> **Respondent IIMB4**: *I came to irrigation because when it is hot we lose what we have produced; with irrigation, a farmer is able to irrigate and produce maize, tomato, beans, garlic, and cove, get enough food for my family and support them to go to the school.*

5.4.2 Learning processes

In this section I, like in Chapter Four (section 4.4.2), I discuss learning processes. In the Massaca irrigation association case, these learning processes include workplace learning (section 5.4.2.1) and social learning in the new irrigation schemes (section 5.4.2.2).

5.4.2.1 Workplace learning in irrigation system

The Massaca irrigation association uses a type of gravity irrigation that may require specified competencies in order to achieve efficiency in workplace learning. The workplace learning in the irrigation system is meant to create capabilities, including individuals' attributes, skills, knowledge, experience, and understanding of the object of irrigation system, as outlined in the data extract from a group interview with farmers:

> **Data Extract: Massaca irrigation association interview with farmers, 9 June 2012**
>
> **Respondent IIMB1***: The association themselves do the maintenance: each of the members cleans his or her canal and we also used to join together to clean the channel during the week. When we came here, there was a technician who taught the group how to plant, how to irrigate and how to spray … We learned how to prepare fertiliser, walk two steps and put two seeds in the pit for maize, for example, and to avoid diseases like when maize becomes yellow and to put only three seeds in the hole…*
>
> **Respondent IIMB2***: Farmers are the ones who do the irrigation, I do the follow up to check if they are using the pesticides well, have filed the holes with seeds, if they have used the appropriate steps.*
>
> **Respondent IIMB5**: *All of us clean the canals. We use a schedule, we do this on Wednesdays and Saturdays. However, when the water does not reach the plot and there is a problem, we also do it then.*
>
> **Respondent IIMB3**: *The technician came to show us how to plant, irrigate, and how to spay the crops.*
>
> **Respondent IIMB4***: 'School in farmer field' programme is where I learned about producing in an irrigation system … textbooks where given to the persons who attended the course and they came to explain to the whole group.*
>
> **Respondent IIMB5***: I fertilise the soil myself … We do the cleaning of the canal ourselves … There is a schedule for water supply during the week.*

Taking the above perspectives of the farmers into consideration shows that in Massaca irrigation association, farmers have learned irrigation practices and could practise some activities, such as operating a gravity irrigation system, locating and clearing blockages in the irrigation system delivery canals, operate spray equipment, plant appropriately for the irrigation environment, and maintain the drainage system. However, the farmers did not show abilities to do important things such as measure the irrigation delivery performance, monitor and operate the water treatment process, monitor and operate the waste treatment process, and apply principles of water management and hydraulics in irrigation work. In summary, Table 5.2 presents the farmers' abilities in the Massaca irrigation association as identified via interviews and observations in the Massaca site.

Table 5.2: Farmers' abilities and knowledge of irrigation farming

Learning object	Know	Do not know
Operate gravity irrigation systems	x	
Locate and clear blockages in irrigation system	x	
Measure irrigation delivery performance		x
Monitor and operate water treatment process		x
Monitor and operate waste treatment process		x
Locate and replace faulty components in irrigation system	x	
Locate and clear blockages in irrigation delivery and drainage	x	
Apply principles of water management and hydraulics in irrigation work		x
Operate spray equipment for weed control	x	
Connect irrigation system from drinkable water potable supply	x	
Maintain the drainage system	x	

As can be seen from the data extracts above, farmers in the irrigation system have been learning how to grow different types of crops, such as maize, beans, carrots, garlic, and how to exercise weed control by applying the knowledge they have gained from the training. In the workplace, farmers learn by doing, but the facilitator also uses other learning strategies, such as field demonstrations where the learners can see the results of applying such technologies and knowledge as an incentive to learn quickly and be motived to apply that knowledge. The Massaca irrigation association also uses the field as an example of the experience of implementing new technologies and crops.

Additionally, one of the senior irrigation committee members participated in this training, after which he became a facilitator in the irrigation system. The Project of Ministry of Mineral Resources promoted a workshop for farmers and they were taught the use of minerals for farming purposes and to improve productivity. Learning events also occurred with the purpose of explaining to farmers how to develop organic farming as an alternative and to re-use organic matter to improve soil condition to reduce the use of chemicals.

5.4.3 Social learning in the new irrigation schemes

Avis (2014) stated that the object of workplace learning is the expansion of labour power, thereby facilitating the development of useful knowledge. However, during this process contradictions and conflicts may arise. From this viewpoint, it appears that the social learning within the association starts at the stages when the facilitator and farmers start to engage with constraints in irrigation workplace learning. Hampton (2012) argued that social learning is critical to a process of developing citizens who are proficient in understanding science and technologies. Social learning in the Massaca irrigation association occurs when constraints are faced in various situations, such as the ones described below.

- While they may implement the new knowledge and technology, some farmers do not do this correctly. In response, the facilitator operates in the field with farmers to support the producers during planting, irrigation and harvesting as shown in some of the data extracts from Respondents IIMB1 and IIMB2 above and in the extract below.

  Participant FGMB5: *When the technician comes, I learn if I'm doing things adequately. If not, he explains what is wrong and I do better, because if I don't do it as he explained, I won't have a good harvest.*

- Social learning occurs among the management board and ordinary meetings with all the farmers. Meetings are developed when there are issues to be solved with members of the management board and sometimes with relevant stakeholders and these are sometimes extended to relevant farmers. Ordinary meetings are held, as well as wider range meetings. In ordinary meetings, all members are expected to be involved including the management board and association farmers. In wider range meetings, a wider range of stakeholders are involved as shown in the data extracts below.

  Data extract: Massaca irrigation association, focus group Interview (7 February 2013) with association management committee, farmers, CIDAE, Agrarian Institute

  Participant FGMB1*: We used to set meetings within the management board and with the wide ranging assembly and the concerns are related with the following: water fees, equipment that needs repair, membership, debts…*

  Participant FGMB4*: The most regular problem is water shortage, which has to do with the location of the plot in the association.*

  Participant FGMB1: *The level of participation is too low, almost 25% of the members are from the city, the natives sometimes give the plots to the fellows from the city and most of the time they have land, but they are not in the association. They don't come to the* *meetings and they send the workers, and that is not good because they don't transmit the issues of the association appropriately to the main irrigation member.*

Participant FGMB1*:* *Sometimes we call the owner and the result is lower, not 100% attendance.*

Participant FGMB6: *The associates participate by giving their ideas and then we take the conclusions to the meetings, which happen on the weekend and when there is an emergency.*

Participant FGMB1: *The associates do not follow their tasks and do not pay the fees, and say that they do not pay because they don't receive water – sometimes they have their reasons.*

- Social learning also occurs among farmers in the absence of facilitator: when they face problems, they explain things to each other, as shown in the data extract below.

  Participant FGMB5*: I'm a farmer but when I see my colleague farmers doing things wrong in the irrigation system, I approach them and explain to them how to do it because I have much experience with irrigation.*

Social learning occurs when the farmers are performing irrigation and cropping activities, when more knowledgeable farmers converse about better way of doing things. This happens when one farmers see that the crops are not growing well. The issue is that farmers in the irrigation system may be associated by water or by land and that affects the overall process of functioning the irrigation system. In the case of Massaca, they are associated through the land and each farmer is responsible for his or her plot. What happens is that individual farmers produce according to their individual plan, each find their way to produce and sell the products. Social learning may be affected by this, as shown in the data extract below:

Data extract: Massaca irrigation association, focus group Interview (7 February 2013) with association management committee, farmers, CIDAE, Agrarian Institute

Participant FGMB3*: When I see someone who is not doing well in irrigation system while cropping – because we understand each other and I have more experience I approach that person and I explain how to do things better.*

In terms of variations in how different farmers interpret and use what they learn, in most cases all farmers follow what the facilitator says. However, some farmers apply that information and others do not necessarily do so. In the interview with the extensionist, participant FGMB2 (personal communication, 7 February 2013) said that some farmers used pejorative words when the facilitators were teaching, or claimed what the facilitator is teaching does not make any sense considering that he is very young and the farmers learned farming when the facilitator was still growing up. As result, plots can be observed where farmers have applied weed control and improved technologies, and these tend to have good outputs in terms of productivity, whereas other plots plants are not growing well because the farmers are still practising traditional practices of farming, for example too much seed in the field. Participant FGMB2 (ibid.), the extensionist, stated that those who follow what he teaches get good results. In most cases, the extensionist facilitator, while monitoring the field, insists on, and explains the need to follow his approach to the farmers. He also encourages them to reflect on how they have been doing things. The extract from this interview sheds light on the extensionist facilitators' role in supporting farmers' learning:

> **Participant FGMB2 (Extensionist):** *I have been here since last year, and I do technical follow-up of farmers' activities, I disseminate adequate farming techniques to the farmers, I evaluate the income of the cultivated land, I organise meetings with producers in which we discuss issues such as technologies … I used to introduce new seed varieties, inform about new methods of farming and irrigation.*

In the Massaca case, I also observed that social learning in the irrigation association occurs on the management level when the management of the association strives to cope with irrigation constraints; in the case of Massaca this is often when there is water scarcity.

> **Data extract from an interview with the Head of Irrigation, Massaca association (9 June 2012), focussing on management practices in the irrigation system**
>
> **Researcher:** When you call a meeting, what do you discuss?
>
> **Respondent IIMB1***: In most cases I call a meeting when there is a need to discuss issues* – *mostly when there is problem with electrical machines, meaning there is no water … sometimes when we see that many farmers are not paying the bill and dues, when there is problem with farmers in the irrigation system.*

From the above and from the range of data sources (interviews, observations and focus groups generated for this case study), it is possible to summarise a set of mechanisms that influence learning in the irrigation system (see Table 5.3 below).

Table 5.3: Social learning components (i.e. generative mechanisms) identified in Massaca irrigation association (framework adapted from Kumler and Lemos, 2008)

Social learning capacities	Individual irrigation member	Observation	Management board	Individual members of management team	CIDAE	Focus group (all together)
Identifying and engaging with constraints and contradictions	x	x	x	x	x	x
Ability to work / learn together			x	x	x	x
Understand mutual interdependence	x		x		x	
Trust	x		x			x
Trust in committee abilities	x					x
Response to constraints	x		x		x	x
Ability to introduce new technology	x	x			x	
Ability to perform new practices	x		x	x		

From Table 5.3, the individual members' ability to identify and engage with constraints was evident in the Massaca irrigation association. Collectively they trust each other; some farmers were able to perform new practices in cropping and the management committee was also able to come up with new arrangements in the process of management. The extensionists demonstrated the ability to introduce farmers to new technology and farmers were able in most cases to make use of these. The associates also demonstrated the ability to work together at different levels. However, in some cases farmers also demonstrated little confidence in the management board, with regard to finding solutions to solve the water constraints. All these need to be considered as driving forces of learning in the Massaca irrigation association.

5.5 Who is shaping or influencing the farmers' learning and practice and how?

As can be seen from the sections above, the process of learning in the Massaca case, is mostly influenced by local institutions, through interactions with the association, but is also well supported by extension services, showing that learning occurs between especially the community activity systems, the association management activity system, and to some extent, the market activity system. The educational / extensionist activity system appears to be particularly important for providing new knowledge, demonstration support, and learning resources. Members also learn amongst themselves, and as shown in the data above, some members are not always willing to learn new approaches, which affects their productivity. Learning in the field (or workplace learning) appears to be a particularly important form of learning, but learning from dissonance also appears to be important.

In summary, I was able to observe that learning in the Massaca community-based irrigation association and in relational engagement with other actors occurs as follows:

i. Learning happens between management committees and members of the association.

ii. Learning happens through facilitation by the members of the management board. In the Massaca irrigation association the senior irrigation committee management member was involved in a course on cropping farming and became a facilitator at the irrigation system association.

iii. Learning happens in interactions amongst farmers (i.e. between members of the association). However, as noted above, this group is heterogeneous in term of their shared background. All the farmers have primary education; there are also teachers from the schools who are actively involved in the management activities. Besides farming, farmers have skills in construction, machines and repairs, and they are involved in small businesses in the village. They interact and learn in the process of irrigation activities and cropping.

iv. Learning between facilitators and farmers. As reported above, facilitators working with the Massaca irrigation association are mostly from the extension services and local educational institutions, e.g. the Boane Agrarian School which is located nearby.

v. Learning between members of the management committees. As can be seen in the discussion above, members of the management committee interact with each other about skills. Most members of the management committee have both primary and secondary school education, some are teachers, and learning occurs during the daily management process or when they face disturbances.

5.6 Potential for transformative social learning

In this section I discuss the potentiality and evidence that emerged in the study for transformative social learning in Massaca irrigation association. I discuss this from the perspective of learning, cognitive transformation and social change (section 5.6.1); learning transformations through engaging with contradictions (section 5.6.2), transformative learning through building new agency and activity in irrigation systems (section 5.6.3), and relevant normative strategies for learning and transformation in the Massaca irrigation association (section 5.6.4); as well as reflexivity in and for transformative social learning (section 4.6.5).

5.6.1 Learning and cognitive transformation and social change

As reported on in section 5.4.2.1 above, learning processes in the Massaca irrigation association include workplace learning and various social learning processes. Workplace learning operates mainly in the fields with assistance of an extensionist from the Boane Agrarian Services. Learning is mainly concerned with crop production and weed management. Due to the constraints that farmers face, social learning becomes part of the process. Social learning happens at different levels of the irrigation management processes and is more focussed on realising activities related to operation, maintenance, administration, and planning as well as some aspects of marketing.

Through such learning processes, transformation and social change is expected that could lead to efficacy and efficiency in the overall irrigation system with wider expected social change results as anticipated by the farmers (e.g. to be able to feed their families and provide better for education). Table 5.4 presents the main changes that occurred due to learning practices from rain-fed farming practices to irrigation system farming practices. The table shows that changes have occurred that include cognitive, social, economic, and normative changes.

Table 5.4: Changes in the Massaca irrigation association (cognitive, social, and normative)

Types of changes from rain-fed to irrigation system farming	
Type of change	Argument (based on observations from the data)
Cognitive: Observed via improved knowledge of irrigation system practices (technical production practices and management practices); and knowledge of how to make the irrigation system operate effectively (also via relational knowledge (e.g. knowledge of the need to work together)	• Improved knowledge in irrigation farming and technology • Improved desire amongst members to engage in association activities • Improved need to work together as a group • Improved feeling that they must face the constraints to guarantee the irrigation functioning • Improved consciousness in environmental risk (e.g. soil degradation) • Improved consciousness that following of learning instructions directly relates to crop productivity
Social Changes: As observed by improved social contributions and benefits in the community of irrigation farmers, and new social structures set up to support the new type of farming	• Improved family income • House improvements using bricks • Improved support of education of the relatives • Improved family savings
Normative: prescribed norms that support, motivate farmers	• Established norm that members are involved in irrigation activities • Established norm that achievement of irrigation activities are supported through deliberations • Improved norm related to some aspects of ecological sustainability awareness (water saving), lower use of pesticides, conservation farming practices, although this is not a main feature of the training provided.

As shown in the descriptions in section 5.4.3 above, this change process does not apply to all farmers in the Massaca context. In terms of variation in how people interpret and use what they learn, some farmers are very interested in integrating new knowledge, but there are also some that refuse to learn new practices. Through a social learning process, the extension services have decided to develop new tools, such as demonstration fields to respond to this situation. As noted above, this does appear to attract the farmers, although there are other issues such as the land and fee charges that also disrupt farmers' learning.

5.6.2 Transformation through historical contradictions

Historical contradictions identified in section 5.3 were a source for transformative social learning in the Massaca irrigation association. This section describes some of these historical contradictions that resulted through a workplace and social learning process in improved thinking, new activities, acquisition of new knowledge, and ensuring the object of the irrigation association (see also Chapter Six).

Most of the associates did not have formal instruction on irrigation practices. They have a basic knowledge of farming from their relatives, mostly in rain-fed agricultural practices. This was well recognised as a basic constraint by the farmers as well as the local agrarian services and the association's management committee. To deal with this constraint, an extensionist was tasked to facilitate irrigation practices in the irrigations system in cooperation with the farmers. The facilitator extensionist from Boane Agricultural Services therefore regularly trains farmers in small groups in new technologies and tools for improvement of productivity in the field. Some of the members also refused to put into practice the new knowledge from the extensionist. In response, the extension services developed demonstration fields as a new tool to foster learning.

People working in the plots are not always the owners. This has a consequence at the level of participation. The owners send their workers to the association meetings and mostly those workers are not in a position to decide on matters in the meeting and this affects the overall process of irrigation management activities. This is also linked to the lack of communication between the associates (i.e. owners of the plots and association committee members). This creates new challenges for the management committee that need to be resolved.

As reported on above, some members do not pay their water fees, but are using the plots and water. They develop a large debt. In response, the association decided to restrict water to particular plots and, as a result, farmers became more actively involved in the association deliberations.

To help to expand learning of the irrigation system and how it works, irrigation board members are also systematically in the field to interact with farmers in terms of addressing their constraints. They document and deliberate these either in small group or wider stakeholder group meetings on a regular basis.

Another important observation is that learning in the irrigation system is limited to instruction on irrigation cropping practices and is less concerned with operation and maintenance of the irrigation system, and water delivery to the crops. There is also very little instruction in more sustainable approaches to production (e.g. conservation farming).

There is some evidence that the process of learning for transformation in the Massaca irrigation association has been influenced by the elimination of constraints, or what Bhaskar calls absence (see section 2.5.5.2). It is clear from the above, that while many difficulties still exist, there is an emergent process of transformative learning that seems to be responsive to difficulties and constraints, as the management committee and the technical support services seek to be responsive in the situation. These efforts are oriented towards the object of increased food production and making the transition from rain-fed to irrigation system farming.

5.6.3 Building new agency in the irrigation association

As also discussed in section 4.5.3, agency refers here to the breaking away from the given frame of action and taking the initiative to transform it. Bandura (1989) noted that agency depends on an actor's beliefs about his or her capabilities of exercising control over a process, in this case community-based irrigation system activities. Irrigation systems in an association require that it be operational and sustained for the longer term. So, the chain of activities reported on above in section 5.6.2 shows agency for systemic reflection at different levels, i.e. of learning to overcome constraints, although this does not always seem to be a smooth or easy process. Expansion of new agency in learning processes aligns with critical reflection associated with challenging beliefs, feelings, past practices and habits, or value judgments. As indicated above, emergent agency in the Massaca irrigation association context is related to the move from rain-fed practices to irrigation practices, and not everyone in the irrigation system is willing to engage in the critical reflection and changes in their past practices and habits, even if new knowledge and practice is introduced. Where agency changes are taking place, and where they result in improved food production and income levels, this seems to be manifested through a critical discourse on past practices (rain-fed) irrigation activities, and through a willingness to experiment with new approaches. Interesting though in this case study, is the fact that some farmers were practising both systems simultaneously by having other plots that were not in the irrigation scheme. Where farmers are involved in adopting the irrigation association guidelines and approaches, there is evidence that they are building new forms agency for a wider 'portfolio' or range of approaches to farming and food production.

As reported in Chapter Four (section 4.5.4), Engeström (2005) suggested that individual agency can be understood as a move away from a certain frame of action and the undertaking of initiatives to transform it. When a group of people do this and collaboratively form new productive activities in which they engage, there is evidence too of collective transformative agency (Engeström & Sannino, 2010) which in this case is shown in the transition processes that are occurring from rain-fed farming practices to irrigation farming practices amongst some farmers. Thus, in the case of Massaca, the new agency that is created is related to the move from rain-fed subsistence practices to slightly higher levels of irrigation led farming production. However, farmers in some cases are also using their agency to maintain both systems of farming simultaneously.

5.6.4 Reflexivity

As mentioned in section 4.6.5 on transformation, there are calls for constant reflexivity of the irrigation system and practices, so that internal contradictions are inferred and the system continues to be robust. The greatest concern in the Massaca irrigation association is water scarcity, which together with lack of maintenance capabilities and technology, and problems with the fees and land ownership system, creates challenges for the system. Reflexivity in this system is shown in the actions of the extension services who improved their approaches to training, and amongst the management association who have sought ways to resolve the payment and land use issue. Reflexivity is also evident amongst the farmers who are producing food using new approaches, while still retaining a knowledge base related to rain-fed agriculture, in response to and perhaps as a ‘hedge’ against potential failures of the irrigation system and water scarcity threats. Reflexivity is also found in the history in which farmers understand the advantage of being in an irrigation system and practise the irrigation cropping practices; for example, farmers started to compare the yield they used to get through rain-fed irrigation against what they get from irrigation systems, and they have shared this knowledge with other farmers, who have also since joined into the irrigation system approach to farming. There is as yet little reflexivity evident in relation to the marketing and selling activity system challenge as most of the effort appears to be going into the production systems.

5.7 Synthesis

In this chapter, critical realism has allowed me to describe the empirical and actual dynamics of the Massaca irrigation association through the identification and analysis of the dynamic of the activity systems found in this context. The chapter further dealt with identification of dialectical contradictions within and between the activity systems, which allow for the process of transformation in the irrigation system. As explained, learning in the Massaca irrigation association occurs through workplace learning and social learning and can lead to the creation of new agency and capabilities that sustain the system by ensuring good yields and continuously improved management practices and social status, but such a process is not guaranteed as not everyone is willing to change their historical-cultural practices for new ones. For this reason, I identified some aspects of the learning as transformative social learning. Workplace learning operates through formal instruction on irrigation, operation, maintenance, and crop management, while social learning takes place through constraints faced by the association while applying the new knowledge and new technology, and in the process of administration and planning of irrigation activities. Some of the identified contradictions within the activity systems are still subject to further analysis in the change laboratory workshop, which is discussed in more detail in Chapter Six.

CHAPTER SIX

Expansive Learning in Irrigation Associations

6.1 Introduction

This chapter examines how transformative social learning can emerge through expansive learning processes that include the identification of contradictions and new solution modelling through Developmental Work Research (DWR) and Change Laboratory Workshops (CLW) (see section 3.3). The research questions that are explored in this chapter are: (i) can, and how can, new learning be facilitated through sharing of new knowledge and decision making amongst farmers, with support from a developmental work researcher?; (ii) how do farmers engage with transformative practices (or not) through the social learning processes and interactions that become possible in a facilitated expansive learning cycle?; and (iii) what are the outcomes of expansive learning in terms of its existent and potential transformative social learning and practice outcomes?

6.1.1 Locating expansive learning in irrigation associations

As described in Chapter Three, section 3.3, the evolution of activity theory can be described in three generations, with each generation developing its own unit of analysis (Engeström, 1996). The first generation focussed on Vygotsky's notion of mediated action; the second generation built on Leontev's notion of activity system; and the third generation, which has emerged most recently, built on the idea of multiple interacting activity systems focussing on a partially shared object (ibid.; Engeström & Sannino, 2010). This research aligns with the third generation of activity system theory and examines how transformative social learning can emerge through expansive learning processes. As discussed in Chapter Three, according to Engeström (2001), Developmental Work Research is a methodology for expansive learning. This concept offers a structure to understand learning practices, which involves knowledge and skills from the participants and provides aggregation of capacities.

To contextualise the theory of expansive learning, Engeström and Sannino (2010) noted that the theory of expansive learning puts the community as learners on a pathway of transformation, and allows the creation of a new culture of embedded practices and activities. It also allows for the formation of new understandings of theoretical concepts associated with activity systems. An important issue is that with expansive learning, learners learn things that are still not there in their worlds, and the learners together construct a new object and concept for their collective activity, and implement this new object and concept in practice. Engeström and Sannino (2010) noted further that traditional modes of learning deal with tasks in which the content to be learned is already well known by the people who design and implement various learning programmes. However, when there is a need to redefine processes or objects where nobody exactly knows what needs to be learned, traditional modes of learning are not enough. The design of a new activity (externalisation) and the acquisition of new knowledge and skill required (internalisation) are increasingly intertwined and they merge in expansive learning activity (Engeström, 1999a).

Engeström (2007) argued that expansive learning typically calls for a formative intervention based on the principle of double stimulation. Expansive learning is described as a process of concept formation. In irrigation system farming, expansive learning corresponds with the creation of new, expanded activities that are object-oriented and concrete and that concretise the transition from rain-fed to irrigation system farming (Engeström, 2001). Expansive learning has as its main feature building the zone of proximal development, "the distance between everyday actions of individuals and the historically new forms of societal activity that can be collectively generated as a solution to the double bind potentially embedded in everyday actions"" (Engeström, 1987, p. 174).

Intervention can be defined as “purposeful action by a human agent to create change” (Midgley, 2000, p.13). The consequential developmental work change actions in Change Laboratory processes are mostly undertaken after and in between the laboratory sections (Engeström, Puonti & Seppänen, 2003). In long-term intervention processes, researchers can reflect on the action that has emerged over time by collecting various types of follow-up data and organising follow-up sessions (i.e. using historical data to describe the history and context of the Massaca and Macubulane cases – (see Chapters One, Four and Five). Change Laboratories are developed based on use of ethnographic data from the activity settings in which they are conducted. In situ ethnographic data using interviews, observations and focus groups (amongst other techniques) is gathered on critical constraints and contradictions in the activity system (see sections 4.3. and 5.3) and this is then used as mirror data in the change laboratory workshop. This mirror data is used as the first stimuli "to stimulate involvement, analysis and collaborative design efforts among the participants" (Engeström, 2008a, p.14). In CHAT, the basis of expansive learning is to focus on learning processes in which the object of learning is transformed from individuals to collectives and networks (Engeström & Sannino, 2010).

6.1.2 Preparation for and process of the Change Laboratory Workshops

The expansive learning process in this study, as discussed in section 3.3.2, followed the Development Work Research (DWR) cycle as outlined in Figure 3.7. Specifically, in both irrigation systems association, the design of DWR involved cycles of workshops and activities for a period of 18 months from 2012 to 2014. The details of these are provided in Chapter Three.

The **design** of the Change Laboratory Workshop (CLW) in the irrigation system context involved a first phase of fieldwork in the irrigation associations with individual and focus group interviews with farmers, management boards, and relevant local institutions; in addition, there had been document analysis of relevant reports with respect to the Macubulane and Massaca irrigation associations (see section 3.5.3). I used this data to describe the activity systems (see Chapters Four and Five), and to identify the contradictions for use as mirror data in the CLWs, and to develop an understanding of the learning processes in these two irrigation systems (Chapters Four and Five).

As an interventionist researcher (see section 3.5.3), I also planned to use the following **learning strategies** for CLW development in the irrigation system context. I had to create an environment that engaged, motivated and stimulated learning, and I had to prepare the contradictions (mirror data) in such a way that they would be clearly understood and recognised by the Learners in the CLW. This was quite complex as there were a diversity of learners from the associations, local institutions, and farmers, all with different capabilities and also with different literacy levels. I also had to explain the process of CLWs to participants so that they understood what we would be doing together, and I needed to facilitate the workshops in such as to encourage active inputs from participants. Considering the different backgrounds of the participants, I had to ensure them of the relevance of their active participation and make sure each had the opportunity to respond to and present ideas. I also felt that it would help to present actual ideas from irrigation schemes developed by other associations in Mozambique and around the world and to draw attention to history, issues and challenges in the irrigation systems. Importantly, I needed to create an environment that was inclusive and respectful of all participants' contributions, encouraging mutual recognition of the abilities, aspirations and background knowledge of participants in the CLW settings.

The **process** involved following the sequence of learning actions as outlined in Figure 3.7. In the case of the two irrigation systems I designed a CLW for irrigation board management teams and farmers; and a broader CLW involving local authorities and education institutions. In the case of the Macubulane irrigation association, I had to also design a mini CLW for the change laboratory for the sugar cane company. Workshop material was prepared for questioning and identification around the contradictions, which provided the mirror data. Mirror data was collected via individual interviews and focus groups, and was synthesised into contradictions and preliminary stand points / perspectives on the contradictions, and then displayed for further analysis and engagement in CLWs. CLWs therefore involved display and further collective analysis of mirror data, meaning we undertook a comprehensive review of the contradictions in the activity systems together. In general, the first step involved questioning, criticising and assessing how irrigation systems practices worked in the past with a discussion on present constraints. In this way, the expansive cycle began with individual subjects questioning accepted practices, and it gradually expanded into a collective engagement with shared contradictions and tensions, moving towards modelled solutions and ways forward.

6.2 Expansive learning in the Macubulane irrigation association

6.2.1 Brief summary of the process

Expansive learning processes involved all members of the association, representatives of the agrarian school, SIDAE, local leader representatives, and the researcher (see Appendix A). In Macubulane, I started the expansive learning process with an explanation of the (i) context of the study, (ii) theories and methodologies, and (iii) relevance of expansive learning (in simple language and discourse so that all could follow) so that participants could understand the process they were engaged in, before we moved into discussion on the actual contradictions and working with the mirror data, and modelling of solutions which took up most of the workshop. Table 6.1 provides an overview of the Change Laboratory Workshop programme.

Table 6.1: Programme of the Change Laboratory Workshop in Macubulane

Macubulane DWR programme	**Day 1: 09/05/2013**		**Day 2: 10/05/2013**	
8:30-9:00	Programme introduction	Facilitator	Presenting, identifying and reflecting on critical contradictions in the irrigation association	Facilitator/ participants
9:00-09:30	Presentation 1: the scope of the research and research methodologies	Facilitator	Reflecting on critical contradictions in the irrigation association	Facilitator/ Participants
09:30-10:00	Presentation 2: Research theories • CHAT, activity systems and contradictions, expansive learning • Critical Realism: Bhaskar MELD	Facilitator	Modelling solution	Facilitator/ Participants
10:00-10:30	Break		Break	
10:00-13:00	Presentation 3: Activity systems, contradictions/absences in activity systems in the irrigation association	Facilitator/ Participants	Modelling solution	Facilitator/ Participants
13:00 13:30	Lunch		Lunch	
13:00-15:30	Discussion on activity systems and contradictions/absences in Macubulane association	Participants	Preliminary examination of the solution	Facilitator/ participants

6.2.2 Concept re-configuration in the Macubulane irrigation association

Engeström and Sannino (2010, p.2) stated that "the theory of expansive learning puts primacy on communities as learners, on transformation and creation of culture, on horizontal and hybridisation, and on the formation of theoretical concepts". In the light of this, I started by questioning the participants of the association, encouraging them to share their understanding/meanings of (i) the concept of irrigation systems, (ii) irrigation system management, (iii) knowledge systems in irrigation, and (iv) practices used in the system. The reason for questioning their understanding of these concepts was to ensure that everyone could participate in the discussion on the shared object (irrigation system management). It was important for participants to have a shared understand of these complex concepts, because participants were from different institutions and different backgrounds. The aim was to show them that although each activity system has its own object, they all relate to a broader object of the irrigation system and contradictions are related to those activity systems. I also shared with them how the broader objective calls for an understanding of community-based irrigation management, resulting from national policy change in the country, which has challenged the existing structures in irrigation schemes and practice. Thus, I began the workshop by explaining the differences between the types of irrigation system management, including community irrigation system management, as explained in Chapter One. I explained my interest in such a system and the composition and relevance of each participant, representing the relevant stakeholders in the learning process, following the learning strategy that I explained above. The data extract below from the CLW shows participant responses to the question: What is an irrigation system? And to a question related to irrigation management.

Data Extract from CLW 9/5/13
Researcher: What is an irrigation system?

Respondent CLWMM1*: An irrigation system does not depend on rainfall, where the farmers go to irrigate the land according to the need of water in the production process, the irrigation system have added value because we always have water and can produce.*

Respondent CLWMM9: *Maybe I can say that irrigation systems differ from the rain-fed [system] because that depends on the rain. Communities irrigate in consonance with the water needed in the field, but it is important to note that the system is very costly, requires fuel, machines or electro-pumps. So, that system is not for anybody, but for those who can afford. […] the state helps those who are near a body of water, and the communities that work as an association in order to cover many members.*

Respondent CLWMM2: *The irrigation system differs from rain-fed, considering that it does not depend on the rain and its use is a sign of developing agrarian activity.*

Researcher: What is community-based irrigation management?

Respondent CLWMM2*: In a community-based irrigation system, the control and maintenance is done by a small association with middle-level production.*

Researcher: What is management?

Respondent CLWMM10*: Management means establishing efficiency (has to do with rational use the resources, intensive use of materials) and efficacy (has to do with the results, low cost of production and high profits).*

Respondent CLWMM2: *Management means that the community does planning and makes decisions.*

Respondent CLWMM4: *Management is to guarantee the functioning of the system, which is to produce in a sustainable way, in terms of the income of the association, it must maintain the functioning of the irrigation system.*

Respondent CLWMM2: *Management has the dimension of fiscalisation.*

Researcher: What does efficiency mean?

Respondent CLWMM10: *It means to use what is necessary to fulfil the production plan activities.*

Respondent CLWMM4: *Creating capacity in the association, avoid seeking external technicians.*

Respondent CLWMM12: *Fulfil the agrarian calendar, irrigation plan and maintenance plan.*

What the responses in the extract above show, is that there was a varied understanding of management. In the workshop, we agreed that irrigation system management is a set of actions, involving administrative, legal, and financial aspects with the objective to reach efficiency and efficacy of the use of the irrigation system. Actions include planning, administration, and finance, which are done by the associates in order to guarantee the functioning and sustainability of the irrigation system.

To reach that goal, agreement was reached that the association should:

- use the necessary resources, while not overusing the available resources, and strictly follow up on the production plans and activities in the irrigation system;
- promote the capabilities of the members of the association, so that a desired performance of activities can be ensured and that members are able to engage efficiently in resolving problems of the association;
- follow the agrarian calendar, irrigation plan and management plans;
- design an annual production plan, including all costs of production. (CLW 9/5/13)

After discussing the irrigation system management concept, some participants did not clearly understand what efficiency of the irrigation system entailed. Together we agreed that efficiency means "to produce the maximum amount possible in terms of tons per hectare, reduce production costs and avoid overuse of available resources, for example avoid water loss" (CLW 9/5/13).

Having re-conceptualised the concept of an irrigation system, I then presented and discussed the overall object of irrigation systems, as in Figure 6.1 below. To facilitate learning and resolution of constraints, I introduced the association's activity systems in the change laboratory workshop. We went through the components of each activity system within the irrigation system and the relationships between particular objects of the activity systems and the broader object of irrigation activities and management.

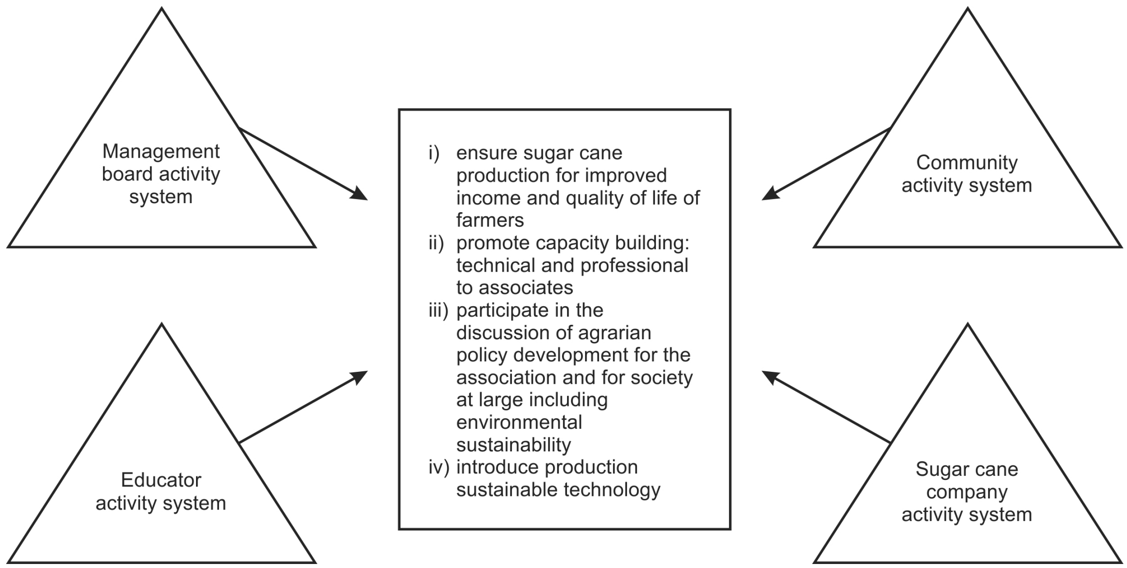

Figure 6.1: Irrigation association object

The discussion of the object of the irrigation system allowed learners to see the existing particular activity system and how it is connected, the composition of each activity system and the interdependency of activities to ensure the desired efficacy. To stimulate this, learners were asked to analyse their own activity systems within the association.

6.2.3 Identification of contradictions

During the analysis and discussion of activity systems within the irrigation system, the participants of the change laboratory workshop identified and reflected various contradictions within the system, based on the mirror data that I shared with them (the contradictions as described in Chapter Four – I shared mainly the manifestations of the contradictions with them as observed). Described below are the final set of contradictions that emerged as priorities during the discussion. NOTE: These are related to the mirror data on the contradictions as defined in Chapter Four, but are represented according to local understanding and wording here with reference to the more in-depth interpretation of the contradictions using CHAT analysis in [ ] brackets.

- *CONTRADICTION 1: Not all members have the same understanding of what it means to be part of the irrigation system association. A reason that was given was that the methodology of* *the association is not adequate and that there are no concrete activity plans or continuing capacity building for the farmers. There are some learning programmes, but once the seminar finishes there are no follow-up programmes and the farmers lose motivation. The association lacks capacity or resources to run seminars. [This is a secondary contradiction* ***between mediating tools and subjects*** *in the farmers' activity system; see also the contradiction* ***between subject's commitment to the collective objectives*** *described in section* ***4.3.1.3.****]*

- *CONTRADICTION 2: There is an internship programme and a field work programme in which learners form the agrarian Institutes near the irrigation system are taken to the field for soil preparation, seeding and harvesting. However, the problem is that the internship programme only takes one month and learners cannot follow the whole cycle of crop growing. The participants think that the minimal period for internships should be three months. [This is a contradiction in the* ***mediating tools of the educational activity system****; see related contradiction at the tools node between knowledge provided and knowledge needed for irrigation system development as described in section* ***4.3.1.2 4****.]*

- *CONTRADICTION 3: A major problem is the lack of knowledge of the statutes of the association, in terms of rights, tasks and responsibilities. Due to this, farmers did not know what are they supposed to do in the association, who is responsible for what? What are the duties? [This is a contradiction between the* ***rules and subjects in the association;*** *see related contradiction* ***at the tools node between prior experience and current expectations*** *in section 4.3.1.2.]*

- *CONTRADICTION 4: The contribution of farmers in terms of paying taxes is not successful, because the association does not have any capacity, the seeds are not improved ones, there is no farming input such as fertilisers. [This is a manifestation of a secondary* ***contradiction between rules, subjects and mediating tools****; see contradiction* ***between the division of labour and the rules*** *described section 4.3.1.3.]*

- *CONTRADICTION 5: The members of the management board are still unclear of the exact tasks they ought to perform. [This is a* ***contradiction between rules and subjects;*** *see related contradiction at the tools node between prior experience and current expectations contradiction in section 4.3.1.2.]*

- *CONTRADICTION 6: There is a need for better knowledge on activity planning. [This is a* ***contradiction in mediating tools and subjects****; see related contradiction at* ***division of labour node between requirements for regular sugar cane irrigation during the day*** *in section* ***4.3.1.2.****]*

- *CONTRADICTION 7: There is a need for better irrigation planting. Farmers recognise that they practise irrigation cropping without rigour. Another problem is that the members do not know how to optimally use fertiliser. [This is a* ***contradiction in object and mediating tools****; see related contradiction between the division of labour and the rules in section* ***4.3.1.2.****]*

- *CONTRADICTION 8: There is no rigidity in what people do with the loans they receive from the association. The problem is that there is no discussion of how that money is going to be used or how and when the money will be repaid. Even when the purpose of the loan is known, some members may use it for other activities rather than for activities that may bring them income. [This is a* ***contradiction in rules****; see related contradiction* ***between subject's commitment to the collective objectives and the rules or policy objective of community-based irrigation scheme management that requires collective decision making*** *described in section* ***4.3.1.3.****]*

- *CONTRADICTION 9: A main complication is that the members and the management board are not always on the same track and they do not share the same vision. There are often problems with the management of the funds, as people ask for funds they do not repay. In this case, the problem lies with the management. [This is a* ***contradiction between farmers and management board rules and mediating tools;*** *see related* ***contradiction between the division of labour and the rules*** *in section* ***4.3.1.3****.] (CLW data 9/5/13)*

Articulating these contradictions was as a result of reflection. As can be seen from the above, these were related to, but not direct 'replicas' of the data generated for the descriptions in Chapters Four and Five (the mirror data). The workshop engagements around contradictions therefore helped to refine and also focus the priorities that appeared most significant to those present. In the workshop, we used the contradictions as defined in the CLW – noted above, to provide the priorities that were then used to engage with solution modelling, which is described in the following section.

6.2.4 Reflecting on responses to the contradictions

Engeström and Sannino (2010) described the process of expansive learning as a movement from actions to new activity. Engeström (1987) explained that the essence of [expansive] learning activity is production of objectively, societally new activity structures (including objects, instruments, etc.) out of actions manifesting the inner contradictions of the preceding form of the activity in question. […] While traditional schooling is essentially a subject-producing activity and traditional science is essentially an instrument-producing activity, [expansive] learning is an *activity-producing activity.* (original emphasis, p. 125)

In the change laboratory workshop in the Macubulane case, the process of creating a solution, or building a new activity, consisted of collective reflection on the possible alternatives to overcome the constraints that were identified and described in section 6.4.3. The framework for engaging the contradictions is presented in Table 6.2, showing the contradictions, together with responses and reasons for responses.

Table 6.2: Framework for contradiction analysis and response

Contradiction	Response
CONTRADICTION 1: Not all members have the same understanding of what it means to be part of the irrigation system association [secondary contradiction ***between mediating tools and subjects*** *in the farmers' activity system]*	Develop a course on the expanded meaning of irrigation association development. Create a vision for the members in line with the association's vision through a dissemination of irrigation statutes and vision, rights, tasks and responsibilities of the members.
CONTRADICTION 2: Field experience in internship programme too short [primary contradiction in ***mediating tools*** *of the education activity system]*	Provide for a minimal period of three months for internship's proposal for sustainable irrigation management emerging activity in the curriculum. Interns will observe and learn full cycle of cropping production.
CONTRADICTION 3: Lack of knowledge of the statutes of the association, in terms of rights, tasks and responsibilities [secondary contradiction between ***rules of irrigation board and subjects*** *in farming activity system]*	Create awareness in members of mandates, tasks, and procedures in the association. Seminars may allow farmers to read and understand the association statutes and relevant norms. Develop course in irrigation planning and administration activities.
CONTRADICTION 4: The contribution of farmers in terms of paying taxes is not successful, because the association does not have any capacity, the seeds are not improved ones, there is no farming input such as fertilisers [secondary ***contradiction between rules, subjects and mediating tools****]*	Develop entrepreneurial courses for farmers to learn to cope with social needs.
CONTRADICTION 5: The members of the management board are still unclear of the exact tasks that they are ought to perform. [secondary contradiction between ***rules and subjects****]*	Produce annual plan for the association. Increase monitoring processes.
CONTRADICTION 6: There is a need for improving knowledge on activity planning. *In the workshop participants also reflected on environmental concerns.* Questions emerged on the causes of soil sterilisation that may occur when practising sugar cane cropping in irrigation systems. This soil sterilisation is caused by (i) fire, and (ii) the use of water, pesticides. Another concern that emerged during the workshop was related to knowledge about water efficiency and sustainable irrigation system management. *[secondary* ***contradiction between mediating tools and subjects****]*	It is important to develop research on how can farmers use sugar cane fields to produce beans; this is an example of emerging knowledge of solutions for soil renovation in response to concerns of environmental risks; beans introduce phosphorus into the soil. There is a need to consider that not all crops need a large amount of water. A study was mentioned on the use of the residues of sugar cane production to feed animals; considering that the area for feeding cattle is scarce, members may start producing cattle feed by recycling the sugar cane waste.

	Proceed with monitoring of soil quality. Adequate soil preparation is important as it helps to avoid water seepage.
CONTRADICTION 7: There is a need for better irrigation planting. Farmers recognise that they practise irrigation cropping without rigour. Another problem is that the members do not know how to optimally use fertiliser [secondary ***contradiction between object and mediating tools****]*	Additional course on irrigation cropping of different crops to achieve increased yield production in the field.
CONTRADICTION 8: Management and rules associated with how money is used or how and when the money will be repaid [primary ***contradiction in rules of the management board activity system****]*	Improve the norms that regulate loans from the association including monitoring process.
CONTRADICTION 9: Lack of shared vision on management board, and how funds are managed and allocated to farmers. In the workshop, the attention focussed on this dimension of the problem: the way payments are made to farmers: associates get paid once a year, after the sugar cane harvesting, and then the outcome is not enough to cover all expenditures of individual farmers during the year *[secondary* ***Contradiction between farmers and management board rules and mediating tools****]*	Support members with loans for new activities Create a team for project evaluation for approval Course on project evaluation Team for monitoring of the projects Design a learning programme for members on how to design a project Improve implementation of the project and monitoring process of activities **To address the problem of the limitations of the annual payment, the following suggestions were made:** Members of association should develop activities in addition to sugar cane plantations; Farmers may collect water for their house and use for other crops, for example vegetables, which avoids waiting for the 12 months it takes to produce sugar cane; Extension of the association fields in the river banks to develop other kind of cropping; The association could practise poly-culture cropping and organic farming using the leaves of the sugar cane to fertilise the soils instead of using chemicals; Create individual projects funded with loans from the irrigation association.

A reading of the data reported in Table 6.2 above shows that the CLW offered a number of relevant possible solutions to the contradictions. The CLW discussions also further refined and extended some of the contradictions, as shown above in the discussions around the environmental issues and the issue associated with how funds were being paid to the associates (annually). The data shows the engagement of farmers in processes of transforming the activities. As can be seen from the responses (proposed solutions) in the table above, these included a range of training, planning, management and evaluation responses, and improved practice responses. These are discussed in more detail below in terms of their potential for transformative social learning.

6.2.5 Potential for transformative social learning in the Macubulane irrigation association

In this section I examine the outcomes of expansive learning within the Macubulane irrigation association in terms of its existence, potential for transformative social learning, and practice outcomes. Learning is understood here as the "acquisition of responses deemed correct in the given context" (Engeström, 2005, p. 66). As Engeström and Sannino (2010) noted, the theory of expansive learning focuses on learning process in which the learning activity itself is transformed from individuals to collectives and networks. In this case, I examine whether the irrigation association's expansive learning can lead to the formation of new and expanded patterns of activity oriented to the object of irrigation.

This section (drawing on data reported in Table 6.2 above) shows the proposed new activities (model solutions) that emerged in Macubulane's activity systems from the CLW deliberations. The proposed new activities included:

Education, training and learning oriented responses proposed:

- Develop a course on the concept of an association, specifically on irrigation associations and how they differ from a rain-fed association. All stakeholders to suggest course content.
- Formalise a course with CIDAE on crop management in irrigation systems unrelated to sugar cane production; this activity falls under the responsibility of the management board.
- Revise the internship programme to include longer periods of fieldwork for the interns.
- Suggest relevant content for a syllabus on communal irrigation management; and revise the content of the irrigation syllabus (researchers and relevant institutions to be involved).
- Develop a course on project design.
- Support learning to consolidate the new activities while designing tasks (workplace-based learning).

Research-based responses proposed:

- Conduct research on the viability of utilising beans after harvesting to renovate the soil.

Planning, management, monitoring and evaluation responses proposed:

- Improve planning and administration in the irrigation association.
- Improve monitoring of irrigation activities by the researchers that are involved in research in Macubulane irrigation association.
- Develop an annual planning framework for the irrigation association.
- Revise the rules surrounding loans.
- Create loan facilities, under responsibility of the management board.

Communication and visioning responses proposed:

- Disseminate and share the irrigation statutes, rules, and norms with all stakeholders.
- Revise the association's vision.

New practices proposed:

- Implement new cropping practices of other profitable crops.
- Develop a plan to practise polyculture cropping by using the leaves of sugar cane to fertilise the soil and reduce the use of chemicals.
- Produce cattle feed by recycling the sugar cane waste.

From the above, some activities may require higher levels of decision-making, and involvement of a broader range of activity systems. For example, influencing curriculum changes regarding the length of the internship programme, infusing sustainable irrigation issues in the curriculum of the agrarian schools and institutes would require substantive engagement with the education activity system, and a wider range of people involved in this activity system (e.g. college principals, national curriculum development partners and the Ministry of Higher Education).

It is also important to note that transformations proposed for Macubulane in the CLW process, entail the creation of something new that will influence the object of irrigation practices and management. It is also clear that all of the activity systems currently engaged in the CLW process would need to be involved in realising these transformations. Figure 6.2 presents my prototype for ongoing collective transformations in the Macubulane irrigation association.

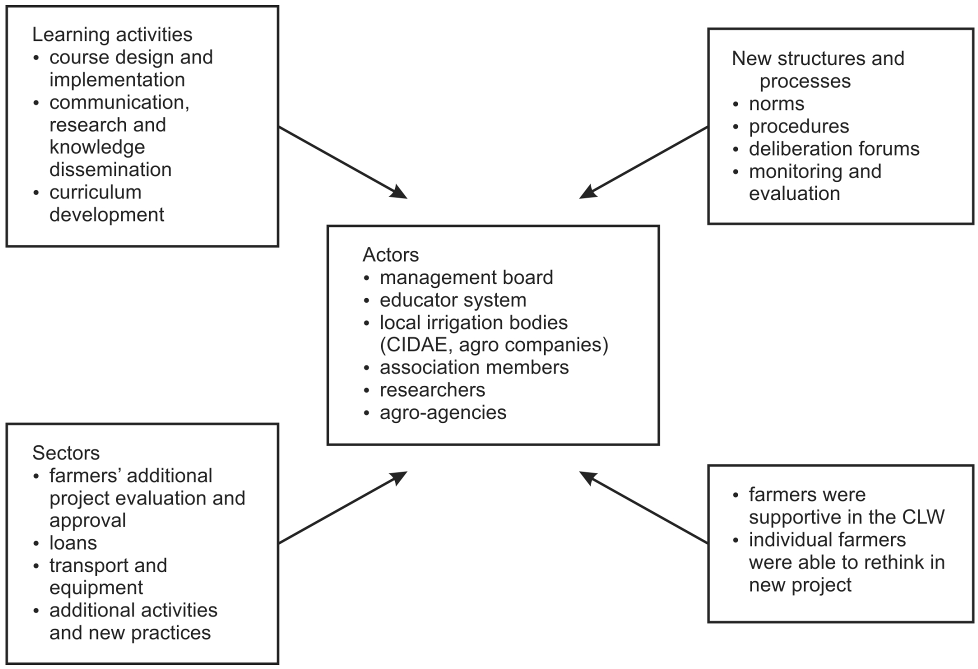

Figure 6.2: Prototype of collective transformation in the Macubulane irrigation association

6.2.6 Expanded agency in Macubulane irrigation association

Building on the work of Engeström and Sannino (2010), Heikkilä and Seppänen (2014) stated that transformative agency is the most important outcome of expansive learning, especially in complex change situations. Engeström and Virkkunen (2007) described transformative agency as participants' capacity to make 'purposeful changes' to their work activity; in this case, it would be related to making changes from rain-fed to irrigation system agriculture that also take sustainability principles into account. As reported on above, I have used double stimulation using mirror data in CLWs to mirror and refine contradictions for further deliberation, learning and development. CHAT researchers report that such methods can help to facilitate the emergence of transformative agency (Engeström & Sannino 2009; Heikkilä & Seppänen, 2014; Mukute, 2010; Engeström, 2011; Haapasaari, Engeström & Kerosuo, 2012; Lindley, 2014, Kachilonda, 2014). Heikkilä and Seppänen (2014) suggested that "agency can be understood as active working through contradictions" (p. 7) as was done in the CLW process and the follow-up reflexive workshops. They described six forms of agency expressions that might contribute to the emergence of agency in formative interventions. Observing agency is not so easy, and Heikkilä and Seppänen (2014), drawing on the work of Sannino (2008), Engeström (2011) and Haapasaari et al. (2012), provided a framework of six types of agency expressions that help to show how participants are working towards taking purposeful action to change their activity. Agency reflects participants' will and ability to shape their activities. Some of the learning outcomes related to agency may become apparent during the CLWs as can be seen in section 6.2. above, but may also become visible after or in between change laboratory workshops. Thus, in order to access the agency created in the Macubulane, subsequent reflexive workshops were designed and two meetings with the management board were held to follow up the activities (see section 3.5.3). From these reflexive workshops and follow-up sessions, I was able to identify different types of agency expressions that had emerged through the expansive learning processes in Macubulane, reported on in Table 6.3 below. This framework is helpful for reflecting on the expansive learning process and its potential for further learning and development.

Table 6.3: Expressions of transformative agency identified in the Macubulane community-based irrigation association (Engeström, 2011; Haapasaari et al., 2012, p. 11)

Type of Agency expression based on Engeström (2011) and Haapasaari et al. (2012)	Evidence of agency from the Macubulane case study – also expressed as agency related to the learning experiences and outcomes
A: **Resisting the change, new suggestions or initiatives.** Directed at management, co-workers or the interventionist	Initially farmers resisted the idea provided by the management board to employ outsider workers, a suggestion which was made in response to the issue that some members were unable to work efficiently with the sprinkler irrigation system, which requires intensive work.
B: **Criticising the current activity and organisation.** Change oriented and aiming at identifying problems in current ways of working	***Respondent CLWMB7:*** *I have realised that working without any basis is different to work with knowledge.* ***Respondent CLWMM7:*** *I want to say thanks for what we have learned … many times we have training, we learn but the teachers do not come again to talk to us and then we forget all what we have learned.* ***Respondent CLWMB9:*** *The method used by the facilitator helped us to speak, open our minds regarding our own worries, and this helped us to dig into our internal problems, and that can help us producers to talk about the problems and possible solutions. This is very rare, because most of the time we get out of a seminar the same way as we went in. But this methodology made us to talk. Thanks, the seminar was very important and interesting.* ***Respondent CLWMB10:*** *I also found interesting the articulation between the association and Inkomati Company to make irrigation working. I found interesting the discussion in the strategies and measures to be taken while moving from rain-fed agriculture to irrigation. However, what needs to be done is to motivate the communities to move from rain-fed to irrigated agriculture that is very important to discuss more widely.* ***Respondent CLWMB1:*** *I have learned from the SIDAE representative about cropping in irrigation fields. We clarified the difference between rain-fed and irrigation systems as we thought they were the same thing, but now we know that it is not the same thing and we have to transmit what we know to other farmers, even if they criticise us when we have to explain that things are not like that and that there are more appropriate ways of doing things.*

Type of Agency expression based on Engeström (2011) and Haapasaari et al. (2012)	Evidence of agency from the Macubulane case study – also expressed as agency related to the learning experiences and outcomes
C: **Explicating new possibilities or potentials in the activity**. Relating to past positive experiences or former well tried practices.	**All the recommendations listed above in section 6.5.2 as developed in the CLW pertain here as they relate to proposals for improving:** • education training and learning • use of research • communication • planning, management and financial administration of the board • monitoring and evaluation • and changes in cropping and production practices Additionally, in reflective workshops and follow up, this type of agency was also in evidence as shown in these data extracts: ***Respondent CLWMB2****: I have learned the four types of irrigation management; advantages of irrigation systems and of being in the irrigation association; and more about the concept that we need to produce more and reduce costs.* ***Respondent CLWMB12:*** *I have learned that many things in irrigation systems needed to planned and need the division of labour, and that planning can give direction in such way we can go further.* ***Respondent CLWMB12:*** *I have learned that the irrigation association needs to have their own planning activities. I understand how the irrigation system works and functions and what issues of maintenance are involved. We had the good advantage of such kind of learning activities in the association.*

Type of Agency expression based on Engeström (2011) and Haapasaari et al. (2012)	Evidence of agency from the Macubulane case study – also expressed as agency related to the learning experiences and outcomes
D: **Envisioning new patterns or models in the activity.** Future oriented suggestions or presentations of a new way of working.	***Respondent CLWMM10****: In this seminar I gained new knowledge and experiences. I learned that there is concept such as Community Based Irrigation Management. Before [these workshops] I was thinking that everything in irrigation was in the hands of the state or private institutions. I found this point to be much interesting. I did not know that the community could have capacity to manage the irrigation system.* ***Respondent CLWMM13:*** *I have learned many things and I concentrated on the theme of irrigation, which was very important because we learned what actually happens in an irrigation system. Irrigation agriculture has many benefits. I learned the different types of irrigation and how to use them. I did not know that sprinkler is used for specific uses, to grow specific plants. Something that we didn't know before is that plants require different quantities of water.* ***Respondent CLWMB14:*** *I thought that an association may only make profit from the sugar cane, but we have learned that there are other crops that are profitable. I did not know that there are places where we cannot produce some types of crops, I did not know that there is need to leave the soil some periods without cropping, that by doing so helps to regenerate the soil. I understood that someone in Management Board should know his/her specific activities, or each member should have their own activity.* ***Respondent CLWMB4:*** *I understood how to work as an associate. What we have learned will improve our lives and increase the productivity of the fields, I think that we could earn more income if we work together, because there are others who delay planting. I think that the association may improve if we implement what we have learned in these days.* ***Respondent CLWMB12:*** *In these workshops we have learned through an exchange of experience. We received information how to work as associates, following the activity plans/system in the irrigation system, how to deliver activities and materials.* ***Respondent CLWMB14:*** *I didn't know that the plots should have some months without production, to avoid soil degradation.* ***Respondent CLWMB14****: Now we have learned many things about agriculture and we would like it if this knowledge and hope can be transmitted to our children, because they are our future.* ***Respondent CLWMB 6****: I thought that the Incomati was supposed to do all activities, but now I understand that we have learned how to do things in irrigation, before we used to be chosen to drive the irrigation association but we did not know how to do that. We also see technician teaching in most associations, and now I have understood that if the association wants to learn something additional in cropping we have to write a letter to the respective institution asking them to come and teach the association.*

Type of Agency expression based on Engeström (2011) and Haapasaari et al. (2012)	Evidence of agency from the Macubulane case study – also expressed as agency related to the learning experiences and outcomes
E: **Committing to actions.** Committing to take concrete, new actions to change the activity. Commissive speech acts are tied to time and place.	***Respondent CLWMB2****: I have learned that we must produce seeds.* ***Respondent CLWMB1****: I thank you for this seminar because before this seminar we thought that we knew everything, but now I have noticed that we did not know anything. I think that we have always to ask those who have knowledge to come and teach the farmers. I'm asking the associates that what we have learned here does not stop in this workshop; we should take it to others members, in order to improve and develop our practices.*
F. **Taking actions.** Reporting having taken consequential actions to change the activity in between or after the change laboratory sessions.	***Respondent CLWMB1****: Before, we used to take fertilisers and spread them over all the fields, but now we know how to measure a certain quantity and introduce it into the sugar cane field to ensure that the sugar cane grows well and strong. Today we use weights to measure the required quantity of fertiliser for one hectare.* ***Respondent CLWMB6****: Today we know how make produce sugar cane and vegetables, I know now that there is no need put a lot of seeds in the hole.*

The instances of agency described above suggest both latent and actual concrete actions for transformation from rain-fed to community-based irrigation activity, thus showing further emergent transformation of the object, building on the description of earlier transformative learning described in Chapter Four (section 4.5). In particular, it seems from the evidence outlined above, that the CLW process has been particularly powerful in terms of providing learning opportunities that helped participants to explicate new possibilities or potentials in the activity (Item C in Table 6.3 above). As can be seen from the data extracts, this involved explicating these possibilities in relation to former experiences and practices, and seeing new potential. However, agency was not limited to this type of agency, but there was also evidence of actual changes in practice, as shown in Table 6.3 above. What is also clear from the data above, is the way in which the new form of *collective, engaged learning* was emphasised and appreciated by participants. Heikkilä and Seppänen (2014) suggested that *reframing* is a type of agency expression where participants reflexively seek to change their own practices. This type of agency seemed to be evident in the reflexivity shown in the changing practice from rain-fed to irrigation agriculture amongst the respondents. As can be seen from their responses, knowledge and understanding appears to be central to this type of reframing reflexivity.

6.2.7 Zone of proximal learning in Macubulane irrigation association

Another important concept in the theory of expansive learning is Vygotsky's *zone of proximal development*. This zone was defined by Vygotsky (1978) as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). As discussed in section 6.1.1, Engeström (1987) reoriented the concept towards learning and development of collective activities and defines the zone of proximity as "the space for expansive transition from actions to activity" (Engeström and Sannino, 2010, p. 4). Figure 6.4 shows a representation of the zone of proximal development in Macubulane.

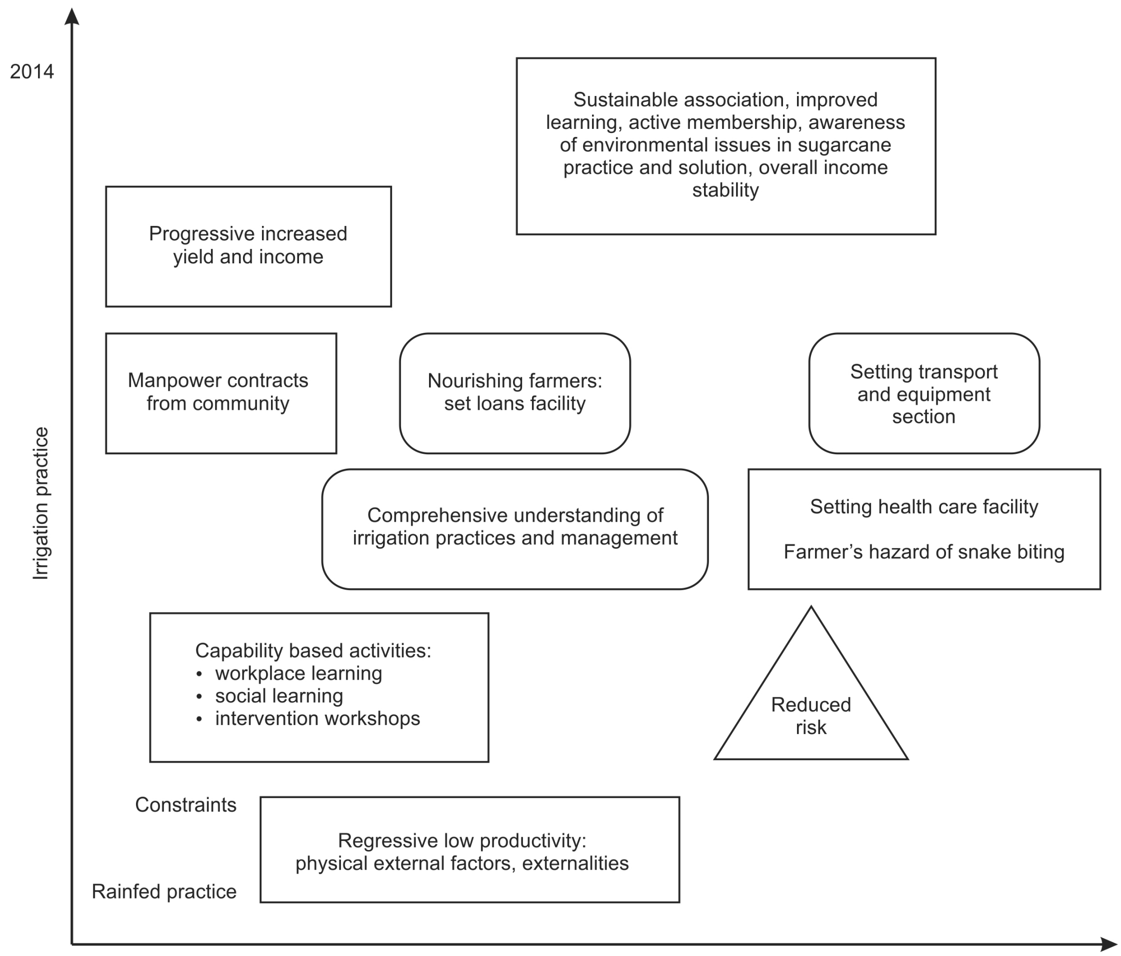

Figure 6.3: Zone of proximal development in Macubulane

Figure 6.3 shows the distance in the practice when farmers were mainly developing rain-fed agricultural practices to when farmers were developing farming practices using community-based irrigation approaches. It also shows aspects of the actual learning development which has emerged through solving constraints, and further potential learning and changes in activity as proposed in the change laboratory workshops (CLW).

The zone of proximal development for learning and development of the new activity in the irrigation system includes: (i) the introduction of new practices (including those that are more ecologically sustainable), and the building of new structures of events, which may include, for example, new learning practices in the irrigation system as proposed in the CLWs and also captured in Table 6.2 above, (ii) the introduction of more collective and praxis centred approaches to learning (as it is shown that this was appreciated – see Table 6.3 above), (iii) and the development of new collective tools for learning that result from ongoing reflexive deliberations and actions that continue in an ongoing manner to address internal contradictions in the activity and the association and leading to construction of learning sustainability of the association. As shown in Chapter Four, this involves a questioning of the actual practices in the process of making the transition from rain-fed to irrigation management system approaches and practices. In Chapter Four I argued that this was an ongoing process of reflexive transformative learning, and in this chapter I have shown that the CLW process can help to surface the contradictions and to heighten reflexive reframing approaches to collective agency development through the expansive learning process.

6.3 Expansive learning in the Massaca irrigation association

6.3.1 Brief summary of the process

The process of expansive learning in the Massaca irrigation association started with an initial workshop that was developed with the management board and farmers, based on interviews with individual members and daily observations of activities in the field as reported on in Chapter Three. The obtained data was analysed and mirror data was produced for the change laboratory workshop. This involved analysis of contradictions as reported on in section 5.3, and design of a response model which took place in the CLWs. Following the first CLWs, further workshops were developed to assess and reflect on the outcomes of learning in relation to the community-based irrigation system object. The expansive learning process in the Massaca irrigation association involved all members of the management committee, members of the association, representatives of the agrarian school, a representative of SIDAE, and a local leader representative.

Similar to the process followed in the Macubulane CLW process, I began the expansive learning process in Massaca with an explanation of the (i) context of the study, (ii) the theories and methodologies, and (iii) the relevance of expansive learning. The CWR in Massaca was held on 02/5/2013 and 03/05/2013 with a similar agenda to that used in Macubulane irrigation association CLW (see Table 6.1).

6.3.2 Reconceptualisation of community-based irrigation system management in the Massaca irrigation association

Data analysis of the individual and focus group interviews conducted prior to the first CLW showed a very clear contradiction related to the understanding of the concept and object of irrigation systems. Therefore, I started the Change Laboratory Workshops by questioning the related irrigation systems concepts. The data extracts below show participant responses, reflecting their understanding of an irrigation system.

Data extract from Massaca irrigation association CLW 02/5/13

Researcher: What is an irrigation system?

Respondent CLWMB7: *An irrigation system means planting and putting water in the soil.*

Respondent CLWMB1*: First the preparation of the land, till the soil using machinery, then water the land, and then planting.*

Respondent CLWMB6*: In an irrigation system, we need to have machines to push water from the river to the "Machamba" [field], then irrigate, put the seeds into the soil, irrigate, and then after germinating it is necessary to develop a maintenance schedule of the field until the harvesting.*

Respondent CLWMB3: *To enter into the irrigation system it is necessary to plough the field, and plant the seeds, and then add water. This is an irrigation system.*

Respondent CLWMB2*: During the phase after the sowing, it is necessary to till the plot, introduce fertiliser, control the pests, and, after introducing the drugs, see if the pests have died or not. Once it is regularised, we irrigate the soil.*

From the above, it is possible to see that the participants were able to describe the concept of irrigation system in terms of cropping, operation and maintenance, sowing, pest control, and monitoring of the cropping process. They also described it in terms of the activities they develop in the irrigation system. However, there were some other issues that were not addressed in the discussion, which I attempted to probe for further description. The extract below shows subsequent responses.

Data extract from Massaca irrigation association CLW 02/5/13

Researcher: What is the meaning of an irrigation management system?

Respondent CLWMB8: *Irrigation management systems mean maintenance, fixing the equipment for pumping water, transport or water addition, processing and that commercialisation in the market is guaranteed.*

Respondent CLWMB6: *The irrigation management system includes the collection of water fees from the members of the association.*

Researcher: What does system mean in this context?

Respondent CLWMB8: *System is a set of activities synchronised in order to achieve a certain objective.*

Researcher: What are the components of an irrigation system?

Respondent CLWMB8*: Infrastructure, water, pumping station, structure for water supply, deposit of accumulation, and the field because water should reach the field.*

Concluding the discussion, we collectively agreed that irrigation system management is a set of activities that includes planning, regulating, operating and maintaining, cropping, commercialisation, financing, and monitoring activities, to increase the productivity and profit and to satisfy the basic needs of the system. This exercise was important as it aligned the participants' understanding of the shared object of the irrigation system, and allowed for a better understanding of the contradictions/absences that surfaced from the system.

While partaking in this exercise, we tentatively identified the relationships between particular activity systems (as identified in Chapter Five) and the activity system objects as well as the overall object of the community-based irrigation system. We then started to discuss the activity systems in greater detail. The participants discussed four activity systems:

- The irrigation committee activity system
- The farmers in the irrigation association's activity system
- The education activity system, with the task to build people's capacity; this includes the college, SIDAE and MICOA.
- The market activity system, including sellers, farmers, government and others.

The workshop participants further reflected on the statutes and found that the object of the Massaca irrigation association system includes:

- Ensuring correct use of the irrigation scheme;
- Promoting capacity and technical assistance for the associates to guarantee the correct use of the system;

- Organising the infrastructure, equipment and resources, to ensure continued operation of the system; and
- Ensuring self-sustainability of the system. (CLW data, see Figure 6.4 below)

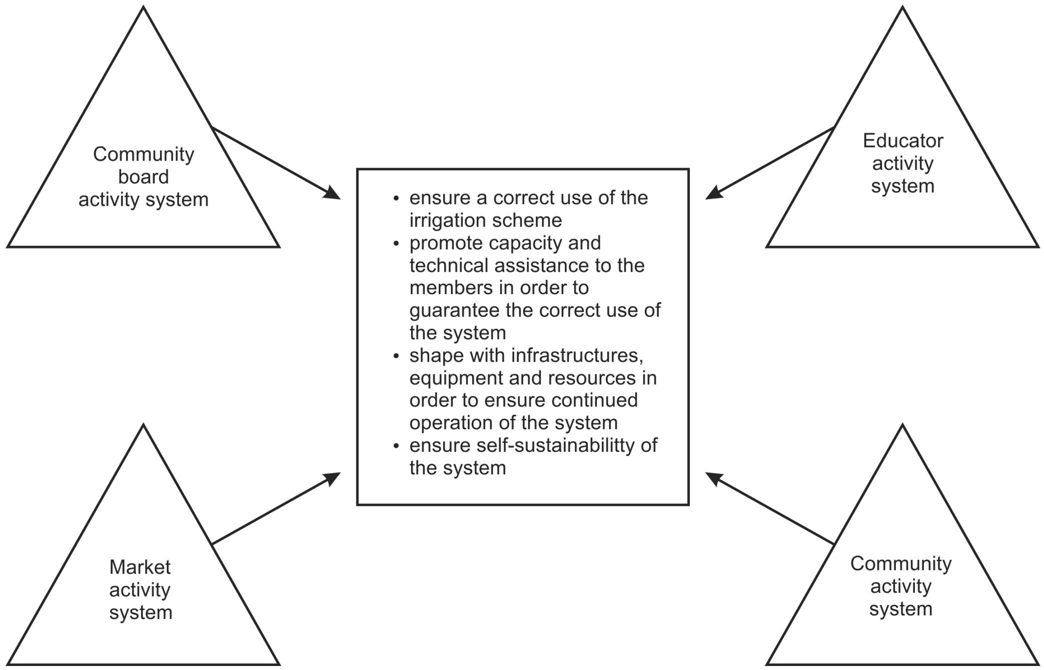

Figure 6.4: Object of the Massaca irrigation association

The farmers demonstrated that they were unaware of the full implications of the association's object and reflecting on it opened their minds to what members are supposed to do or achieve. This exercise, thus, helped the participants to clarify their responsibility as members and as part of management committees. They noted that many members of the association are unaware of their roles and responsibilities in the system, as shown in the data extracts below.

Data extract from Massaca irrigation association CLW 03/5/13

Respondent CLWMB2*: We need to know the operation of social part of the association, the task of the president of association, wide range assembly roles, role of members, meaning that each must know his/her role and task in the association.*

Respondent CLWMB6: *Although the roles are written in the statutes one can read but not understand what it means… We need to have workshops to explain it ... We need to present what we have discussed here in the wide range assembly.*

6.3.3 Identification of contradictions in the Massaca irrigation association

Engeström (2005) stated that expansive transformation occurs when contradictions are aggravated over time. As contradictions intensify, individuals start questioning and challenging the existing norms within the activity system and, thus, the object of activity is reconceptualised into a broader horizon of possibilities (ibid.). Thus, we continued the expansive learning cycle by reflecting on the first stimuli (i.e. mirror data) in the workshop. The participants discussed the contradictions and identified the potential causes and implications of the contradictions. As in the Macubulane case, I captured the way in which the contradictions were understood in 'layman's terms', and then related it to the contradictions analysis in Chapter Five, using CHAT's language of description].

- *CONTRADICTION 1: relates to the water provisioning for the field being inadequate. This is due to obsolete pipelines which resulted in the water not reaching the field in the desired quantity and this affects the plant development. As a result, some of the members see no reason to pay the water fees, as they claim that they do not receive water on their plots. Consequently, the association committee is unable to pay the bills and fails to pay for the maintenance of the system in the form of pumping systems and pipeline repairmen. Water shortage thus becomes a source of conflict. Farmers near to the hydrants and canals, or those who get water, block the water so that it does not run to further plots. The water shortage may occur in the same plot within 80x80 m2 sometimes it is only possible to irrigate parts of it where the water may reach. [This is a secondary contradiction **between mediating tools and Object** in the farmer's activity system; see also the **Contradiction between the rule, object, and division of labour node of community activity system** in section **5.3.2.**]*
- *CONTRADICTION 2: is related to the fact that some members do not plough their plots. This might be the result of the inadequate water provision to the field, as the water users might only use those parts of the field that receive sufficient water for production. The implication of this is the expansion and uncontrolled growth of invasive plants on the plots that are not ploughed. These spread quickly to surrounding plots, affecting those that are developing their crops. This may harm the neighbouring members' production and will affect the overall production of the system, and, therefore, the whole association. [This is a secondary contradiction **between mediating tools and division of labour** in the farmers' activity system; see also the contradiction **between rule and object nodes** described in section **5.3.1.**]*
- *CONTRADICTION* 3: *is that farmers still practice rain-fed farming in the irrigation system, due to a limited understanding of the concept of irrigation management, and limited technical knowledge of irrigation practices. There is a lack of courses specifically on irrigation system development which focus specifically on community-based irrigation system management. As a result, there is an overall low productivity in the irrigation system and a deficient maintenance of the system. [This is a secondary contradiction **between rules and object** in the farmer's activity system; see also the **contradiction in the mediating tools node in the CAS and also in the management board activity system (MBAS) between prior experience and irrigation concepts** described in section **5.3.1.]***
- *CONTRADICTION* 4: *relates to the taxes levied on the water. The board charges for 500 Meticals (MTs - local money) of water fees. Reasons for how and why this tax was estimated at this amount is unclear for members. The estimated tax does not correspond to cost recovery of*

*water supply in the irrigation system. [This is a primary contradiction **in the object node i**n Management Committee activity system; see also the **contradiction in the rule node between rules related to plot allocation and water rights fees** described in section **5.3.1.**]*

- *CONTRADICTION* 5: *relates to the fact that the members of the association have additional land outside of the irrigation scheme, where they practise rain-fed farming. In the wet season, because there is available water, the community opts to produce maize on those lands and they return to the irrigation schemes in the dry season. When farmers do this, the irrigation system gets abandoned for periods of time. [This is a primary contradiction between rules and object in the farmer's activity system; see also the **contradiction in the rule node between rules related to plot allocation and water rights fees** in section **5.3.1**.]*

- *CONTRADICTION* 6: *relates to the fact that some of the members refuse to apply the new knowledge offered by the extensionist advisors. Some members claim they have been practising agriculture for a long time, even before the development of the irrigation system, and that they know how to do it. This signals the tension between the traditional knowledge embedded in the community and the acquisition of new scientific knowledge; some of the members are not motivated to learn new practices. A reason for this might be a lack of understanding of concepts of maximisation of productivity and cost recovery. Almost the entire community does not have any formally acquired scientific knowledge of agriculture, most of their knowledge is developed via historically situated practice. [This is a tertiary contradiction **between rules and subjects** in the farmer's activity system and educator activity system object node; see also the **contradiction between community subjects' knowledge and experience and educators' activity system mediating tools contradiction** described in section **5.3.3**.]*

- *CONTRADICTION* 7: *is related to the fact that the farmers working in the field are not always the most effective members of the association. This has an immediate implication for decision-making, as these farmers are unable to decide on matters without permission of the formal members of the association. [This is a tertiary contradiction **between mediating tools, rule and subjects** in the farmers' activity system and Management Board Activity system; see also the **contradiction between community object and management board activity system rules** described in section **5.3.3**.]*

- *CONTRADICTION 8: has to do with externalities, namely the price oscillation of farmers' products in the market. Sometimes the farmers sell at a very low price when the buyers stipulate the prices. When there is a surplus, or availability of the product is high, prices decrease. Farmers argue that the products sometimes take too long to sell, and they do not have the resources to store the products. Higher levels of availability of products is caused by seasonal factors, and it is difficult to recover costs when this happens. [This is a quaternary contradiction **between mediating tools and subjects** in the farmers' activity system; see also the **contradiction between the management board, community, seller's and selling and delivery activity objects** described in section **5.3.4.**]*

6.3.4 Potential for transformative social learning in the Massaca irrigation association

As outlined in the expansive learning cycle, a very important task of the CLW process is to model solutions to overcome the constraints associated with the contradictions, as described in the previous section for the Massaca irrigation association. This section presents the proposed resolutions that were developed in the CLW process.

Table 6.4: Framework for contradiction analysis and response in Massaca irrigation association

Contradiction	Response
CONTRADICTION 1: relates to the water provision for the field being inadequate. This is due to obsolete pipelines which results in the water not reaching the field in the desired quantity which affects plant development. As a result, some of the members see no reason to pay the water fees, as they claim that they do not receive water on their plots. Consequently, the association committee is unable to pay the bills and fails to pay for the maintenance of the system in the form of pumping systems and pipeline repairmen. Water shortage thus becomes a source of conflict. Farmers near to the hydrants and canals, or those who get water, block the water so that it does not reach further plots. The water shortage may occur in the same plot within 80x80 m2, sometimes it is only possible to irrigate parts of it where the water may reach. [This is a secondary contradiction ***between mediating tools and Object*** *in the farmer's activity system; see also the* ***Contradiction between the rule, object, and division of labour node of community activity system*** *in Section* ***5.3.2]***	Appoint someone in each hydrant to control the water delivery and inform the association committee. When the association management confiscates the plots, these plots should belong to the whole association, rather than be given to another person. The association should hire a lawyer to assist in developing contracts and conflict resolution in the irrigation system. The association should increase the water fees. Considering the number of members, this will help to guarantee the basic payments related to the association's power and water bills. However, there is still no guarantee that all members will pay the fees. So, to overcome this, the association should have some plots where they can collectively produce for funds to support the running costs of the association. They should explain to the community that these products will contribute to the running costs.
CONTRADICTION 2: is related to the fact that some members do not plough their plots. This might be the result of the inadequate water provision to the field, as the water users might only use those parts of the field that receive sufficient water for production. The implication of this is the expansion and uncontrolled growth of invasive plants on the plots that are not ploughed. These spread quickly to surrounding plots, affecting those that are developing their crops. This may harm the neighbouring members' production and will affect the overall production of the system, and, therefore, the whole association. *[This is a secondary contradiction* ***between mediating tools and division of labour*** *in the farmers' activity system; see also the contradiction* ***between rule and object nodes*** *described in section* ***5.3.1****]*	The following was suggested to address the water shortage: Scenario One: Buy a new electro water pumping machine with a capacity of 200 m^3/s. However, this is only possible with a loan from the bank and there is no guarantee that this money can be paid back in monthly instalments. Another idea was to get money by collecting it from the farmers. Scenario Two: Repair the existing pumping machine. The proposal to redistribute unused land to the whole association also addresses this contradiction.

CONTRADICTION 3: is that farmers still practice rain-fed farming in the irrigation system, due to a limited understanding of concept of irrigation management, and limited technical knowledge of irrigation practices. There is a lack of courses specifically in irrigation system development which focus specifically on community-based irrigation system management. As a result, there is an overall low productivity in the irrigation system and a deficient maintenance of the system. *[This is a secondary contradiction* ***between rules and Object*** *in the farmers' activity system; see also the* ***Contradiction in the mediating tools node in the CAS and also in the management board activity system (MBAS) between prior experience and irrigation concepts*** *described in Section* ***5.3.1]***	Participants in the CLW agreed that the association needs to develop a sustainable production plan. Farmer must be informed on what crops are best suited to an irrigation system in winter and summer in relation to rain-fed farming.
CONTRADICTION 4: is that the board charges only 500 MTs (Meticals) local currency for water fees in the association and the reasons how this tax was estimated for this amount is unclear for the members. The estimated tax actually does not correspond to cost recovery of water supply in the irrigation system. This is a primary contradiction ***in the object node i****n Management Committee activity system; see also the* ***Contradiction in the rule node between rules related to plot allocation and water rights fees*** *described in Section* ***5.3.1****]*	To address unpaid water fees, the participants agreed that a methodology must be sought to develop awareness in the community on the relevance and necessity of paying the water fees. The association needs to develop a sustainable production plan. Additionally, it was suggested that the water fees need to be updated. Farmers think that by doing so the irrigation management association will have enough money for running costs of the irrigation system.
CONTRADICTION 5: relates to the fact that the members of the association have additional land outside of the irrigation scheme, where they practice rain-fed farming. In the wet season, because there is available water, the community opts to produce maize on those lands and they return to the irrigation schemes in the dry season. When farmers do that the irrigation system gets abandoned for periods of time. *[This is a primary contradiction between rules and object in the farmers' activity system; see also the* ***Contradiction in the rule node between rules related to plot allocation and water rights fees 5.3.1]***	Farmers must be informed as to which crops grow better with irrigation in both winter and summer, and be told how this relates to crops that are traditionally grown with rain-fed farming so that they can manage a wider portfolio of planting across both irrigated and other plots.
CONTRADICTION 6: relates to the fact that some of the members refuse to apply the new knowledge offered by the extensionist advisors. Some members will state that they have been practicing agriculture for a long time already, even	Reformulate the learning practice. Demonstration fields may help to show farmers and help them realise that if they use the new technology of the irrigation scheme

before the development of the irrigation system, and that they know how to do that. This signals the tension between the traditional knowledge embedded in the community and the acquisition of new scientific knowledge, some of the members are not motivated to learn new practices. A reason for this might be a lack of understanding of concepts of maximisation of productivity and cost recovery. Almost the entire community does not have any formally acquired scientific knowledge of agriculture, most of their knowledge is developed via historically situated practice. *[This is a tertiary contradiction* ***between rules and subjects*** *in the farmers' activity system and educator activity system object node; see also the* ***Contradiction between community subjects' knowledge and experience and educators' activity system mediating tools*** *contradiction described in Section 5.3.3]*	development, they can have higher yields and profits.
CONTRADICTION 7: is related to the fact that the farmers working in the field are not always the most effective members of the association. This has an immediate implication for decision-making, because those farmers are unable to decide on matters without permission of the formal members of the association. *[This is a tertiary contradiction* ***between mediating tools, rule and subjects*** *in the farmers' activity system and management board activity system; see also the contradiction between Contradiction between community object and management board activity system rules described in Section 5.3.3]*	Create better communications structures between farmers and irrigation board members for running of the association. Build capacity of farmers to make irrigation system management decisions.
CONTRADICTION 8: has to do with externalities, namely the price oscillation of farmers' products in the market. Sometimes the farmers sell at a very low price, as the buyers are sometimes the ones who stipulate the prices. When there is a surplus, or availability of the product is high, prices decrease. Farmers argue that the products sometimes take too long to sell, and they do not have the resources to store the products. Higher levels of availability of products is caused by seasonal factors, and it is difficult to recover costs when this happens. *[This is a quaternary contradiction* ***between mediating tools and subjects*** *in the farmers' activity system; see also the contradiction between* ***the management board, community, seller's and selling and delivery activity objects*** *described in Section* ***5.3.4****]*	Farmers must be informed as to what crops are best to cultivate with irrigation in winter and summer, and how this relates to rain-fed crops. This is to help avoid the markets being flooded with one type of product at one time of the year, especially when these come from both the irrigated and the rain-fed systems. Complementary planting practices need to be developed so that farmers can benefit in winter by irrigating crops.

A reading of the data reported in Table 6.4 above shows that the CLW offered several relevant possible solutions to the contradictions. The data shows the engagement of farmers in processes of transforming the activities. As can be seen from the responses (proposed solutions) in the table above, these included a range of deliberations to present a wider range of assembly, planning, management and evaluation responses, and improved practice responses. These are discussed in more detail below in terms of their potential for transformative social learning.

6.3.5 Expanded potential for new activities

This section examines the outcomes of the expansive learning process in terms of its existence and potential for transformative social learning, and practice outcomes. As mentioned in section 6.4.5, expansive learning in the irrigation associations leads to the formation of new and expanded patterns of activity that are oriented to the object of irrigation. The following potential for new activities and patterns were identified in Massaca's activity systems, based on, and extending the data presented in Table 6.4 above.

Technical solutions to contradictions and problems with the activity

- Acquisition of new machines such as tractors will improve the efficiency of the irrigation system;
- Repair of the existing machines will minimise the actual operating system;
- Use of all plots will guarantee greater irrigation efficiency (i.e. avoid waste of water);
- Design of strategies for seasonal production campaigns that are affordable for irrigation products because some crops are seasonal, so farmers can produce those crops that cannot be produced in rain-fed contexts. This will give irrigation farmers an advantage in the market.

Learning and skills development responses

- Develop demonstration fields, where members can observe the process of applying new technologies and the output and profit it produces. It is assumed that if the members can observe the process, they will be more motivated to apply the new knowledge and end their heavy reliance on rain-fed systems;
- Develop skills in irrigation practices related to cropping and management for all members;
- Inform all members of the outcomes of the Change Laboratory Workshop;
- Facilitate regular interactions between learners and staff within the association's irrigation system;
- Develop a course on irrigation systems management;
- Establish an agreement to bring internships to the field.

Communication and participation in the irrigation scheme association management practices

- There is a need to work with institutions such as CIDAE, community leaders, the regional secretary, and the agrarian institute, to facilitate activities of the association committee (through their insight into the association during meetings, in particular in the wide range assembly);
- Update the member database to allow the manager to systematically follow-up on the irrigation activities;
- The indicated head of perimeter hydrant should be a member of the management committee and be involved in the community's board management meetings;

New management principles and practices

- Abandoned fields should revert to the association;
- The basic principle of the irrigation association is that all areas of the irrigation system should be in use;
- Design management plan activities to assist the irrigation board with fulfilling the needs that support the functioning of the system.

Re-mediation and defining of responsibility for mediation of new activities

Engeström (2008b) argued that the creation of new activities is a process of reflective re-mediation. A mediating concept or device can open up entirely new lines of questions and lead to the formation of a new object. This re-mediation differs from goal-rational objectives of change. The new goals are often not intentional products of single activities, but rather the united consequence of multiple activities. The change laboratory workshop helped to validate agency in terms of defining roles for actions to be taken within the association in relation to the creation of the expanded / new form of activity. These are outlined in Table 6.5 below.

Table 6.5: Expansive learning suggested actions with responsibilities ascribed to different actors with a role to play in the formation of the expanded / new form of activity

New action proposed	Responsibility
Acquire new machines	Management board (MB)
Implement new rules and strategies that support the use of the irrigation system, for example, reviewing the members' mandate "all the members should pay the fees and/or produce in the field"	MB and relevant actors
Repair the existing machines	MB and irrigation companies
Design and implement management plan activities to assist the irrigation board to fulfil the needs that support the functioning of the system	Management board
Nominate head of perimeter hydrant	Management board
Update and disseminate the new vision of the irrigation association (i.e. that all areas of the irrigation system should be in use)	MB, educators and SIDAE
Establish an Agreement with Agrarian Institute on Internships	Agrarian Institute and MB
Design strategies on seasonal production campaigns	Educators and SIDAE
Develop demonstration fields, rain-fed systems in irrigation system	SIDAE
Disseminate outcomes of Change Laboratory Workshop	MB and educators
Update the members' database	MB
Strengthen relationship with institutions, including SIDAE, community leaders, regional secretary, and Agrarian Institute, to facilitate the activities of the association committee	MB and relevant actors
Suggest development of a course content on irrigation management	Educators
Contact potential stakeholders about the rehabilitation of the irrigation system	MB

6.3.6 Expanded agency in Massaca irrigation association

As noted above in section 6.1.1, according to Engeström and Sannino (2010), the most important outcome of expansive learning is transformative agency, i.e. the participants' ability and will to shape their activities, and thus to change the world and his or her own behaviour. The following table draws on the expressions of agency analysis tool (see section 6.2.6 above), and provides evidence of expanded agency in the Massaca Irrigation association.

Table 6.6: Expressions of transformative agency identified in the Massaca community-based irrigation association (Engeström, 2011: Haapasaari et al., 2012, p. 11)

Type of Agency Expression based on Engeström (2011) and Haapasaari et al. (2012)	Evidence of agency from the Massaca case study – also expressed as agency related to the learning experiences and outcomes
A: **Rejecting the change, new suggestions or initiatives.** Directed at management, co-workers or the interventionist	***Respondent CLWMB6****: In my opinion, we have to assess all the needs of the irrigation system and calculate the amount needed for further provision. Then we have to make arrangements for all the conditions needed, and know who is going to register the project and ask for a loan from the bank. However, the concern is that the Bank gives us a loan, but then starts to charge after three months. So, we should be in the position to be able to start paying back the loan and the because most farmers as we know, will not be able to give the money back in three months and now the question is that, who is going to pay for that?*
B: **Criticising the current activity and organisation.** Change oriented and aiming at identifying problems in current ways of working	***Respondent I CLWMB2****: I have learned that I did not properly value many things that we used to hear.* ***Respondent CLWMB3:*** *We don't produce garlic because it takes a long period to sell in the market.* ***Respondent CLWMB10:*** *The problem is that we don't understand each other; sometimes we need to deliberate on issues together.*

Type of Agency Expression based on Engeström (2011) and Haapasaari et al. (2012)	Evidence of agency from the Massaca case study – also expressed as agency related to the learning experiences and outcomes
C: **Explicating new possibilities or potentials in the activity**. Relating to past positive experiences or former well tried practices	**All the recommendations listed above in section 6.5.6 as developed in the CLW pertain here as they relate to proposals for improving:** • *technical aspects of production* • *communication and expanded participation with the irrigation scheme board* • *new management principles and practices* • *learning and skills development* • *re-mediation with roles and responsibilities identified* Additionally, in reflective workshops and follow up, this type of agency was also in evidence as shown in these data extracts: ***Respondent CLWMB2****: Here we had an experience exchange, the workshop helped us to open the mind and bring ideas, understanding and thinking of irrigation.* ***Respondent CLWMB7****: We need a strong course on associativism [how to manage the association and the community-based irrigation scheme]* ***Respondent CLWMB6****: Production costs 4 000 MTS [metical][6] for cleaning the soils, 8 000 MTS for seeds, and 18 000 MTS for pesticides, so I think that is worth it to produce beans and maize* ***Respondent CLWMB1:*** *We want the institutions such as universities and CIDAE to come to the wide range assembly, because the explanations that we had during workshops may help to legitimatise the irrigation board activity*
D: **Envisioning new patterns or models in the activity.** Future oriented suggestions or presentations of a new way of working	***Respondent CLWMB3****: I have to thank you for this seminar, and I would like it to happen again. I have learned a lot of things that I did not know the significance, advantages and importance of the irrigation system. I only knew that I have to irrigate from here to there. Before I did not know the difference between rain-fed farming and irrigation farming. I have learned that in the association it is necessary to be well organised and our participation is crucial, and that all this makes it an association. I have learned that an association should have a jurist assistant in order to ensure better functioning of the association.* ***Respondent CLWMB1****: I think that we will generate more income if we work together.*

[6] This is the currency in Mozambique. 1 US dollar = 72 MTS

Type of Agency Expression based on Engeström (2011) and Haapasaari et al. (2012)	Evidence of agency from the Massaca case study – also expressed as agency related to the learning experiences and outcomes
E: **Committing to actions.** Committing to take concrete, new actions to change the activity. Committed speech acts are tied to time and place.	***Respondent CLWMB4:*** *There were things that we knew but we did not understand it, now we can talk and argue with irrigation partners.* ***Respondent CLWMB3:*** *I wish that what we have learned does not end here today, but what we have learned will have value if we put it into practice, today we discuss the issue of water but if we get water we still have to know the value of irrigation, the ideas we got from here must proceed.* ***Respondent CLWMB6:*** *I think that, from today, we will turn the game. I believe that everything will change with the water resolution. I would like to say thanks for the workshop and hope that all we have spoken about here, gets into the mentality of all, and that each of us work in order to overcome the problems that were approached here, I wish that all we have discussed, is also approached in the wide range assembly, for the members to know and understand it.*
F. **Taking actions.** Reporting having taken consequential actions to change the activity in between or after the change laboratory sessions	***Respondent CLWMB2:*** *We have next week the wide-range assembly, we would have gone to this meeting with old ideas but now, because we had this workshops, we will be able to bring the new ideas while discussing our issues in the association.* ***Respondent CLWMB1:*** *We are now developing a new project and contacting national organisation to see how we can recover the irrigation system.*

The Change Laboratory Workshop in the Massaca irrigation association created an opportunity to examine the current collective operation in irrigation system practice, and in irrigation system management, and to access cognitive changes and practice. Significant actions for transformation took place in the Massaca irrigation association during and after the workshops and during the reflective workshop. During this process, it was possible to understand some of the transformations in learning in the Massaca irrigation association in terms of conceptual understanding of community-based irrigation scheme development and management, and the development of proposed solutions to contradictions.

However, in subsequent reflexive workshops farmers, critical reflection raised issues that were not known or discussed during the CLW process. These are complex in terms of efficient resolution in terms of irrigation management. These include:

- The association's management board held a meeting in which most of learning points and proposed solutions developed in the change laboratory workshop were raised and discussed. However, in the Massaca irrigation association a question arose in terms of the implications of the proposal for the management board to increase the water fees. Farmers wanted to know if the fees were raised, would water be guaranteed? This was not easy to answer as this related to a range of technical and competence based issues showing the intersectionality of the issues.
- The management board started identifying potential partners to support the rehabilitation of the irrigation system. However, even if the system is rehabilitated, without the proper agency to manage it, today's problems will re-emerge. Some of deliberation in the association was thwarted because there was still no water available in the fields. Some farmers refused to pay the new water fees if the pumping equipment remains obsolete. So, some of the solutions, as modelled in the CLWs, are still not appropriate.

The data above, however, shows that the CLWs were a good forum for enabling the modelling of solutions, but that time was needed afterwards for farmers to reflect more deeply on the actual practical implications of the solutions elaborated during the CLWs. Mukute (2010) showed that there were several periods of reflection and resistance to proposed solutions modelled before actual changes started to take place. This reflexivity needs to be practice-based, and not merely theoretical. From this, it is possible to see that the expansion of alternatives involves critical reflexivity, in which farmers can also consider and evaluate their proposed solutions in order to decide on how to move forward from there. It is also possible to see from the data that farmers understand that there should be additional learning practices to ensure that proposed solutions can be sustained and more fully implemented.

6.3.7 Zone of proximal learning in Massaca irrigation association

In this section I discuss the zone of proximal learning in Massaca irrigation association. In section 6.2.7 I presented the concept of ZDP according to Vygotsky's understanding and its relevance in Expansive Learning. The table below outlines proximal learning development in Massaca.

Table 6.7: Zone of proximal development in Massaca irrigation association

	Mechanism	Who	Focuses
Zone of Proximal Development	Learning mediation from more capable or knowledgeable institution/person on irrigation activity system and sustainability	SIDAE, universities, agrarian school	Concepts of irrigation systems, crop farming practices
	Emerging learning contradiction from prior experience on rain-fed farming to actual irrigation practices	Farmers	Filtering the advantages of rain-fed to irrigation farming, accepting or rejecting exercise
	Constructing new knowledge while performing new irrigation farming practices	Farmers	Converting farming practices and step by step leaving rain-fed practices
	Emerging capabilities and co-learning new activities	Farmers to farmers	Assigning new structures and activities, supporting other farmers

up to 1996 rainfed → Irrigation system (2000-2014)

Table 6.7 shows that before 1996 farmers used rain-fed practices and later an irrigation system was installed including establishment of associations tasked to run the system. In the zone of proximal development, the learning development mechanism included learning mediation which works as a stimulus for emerging contradiction, followed by construction and performing knowledge and irrigation practices among farmers as a sign of emerging capabilities. In this case, new activities emerged as explained in section 6.5.6. The table also explains the focus of learning development in irrigation systems.

6.4 Synthesis

This chapter has explained and discussed the change laboratory workshops that were undertaken in the two case studies, the Macubulane and Massaca community-based irrigation associations. It presented the process of the intervention workshops and the learning outcomes that were achieved through this process. The processes included cyclical workshops, namely (i) data collection to produce mirror data; (ii) a broader change laboratory workshop process; and (iii) reflexive sessions to assess learning and viability of the proposed solutions from the CLW processes. The results reveal that learning for transformation occurred in both case studies and this learning was expressed in terms of re-conceptualisation of irrigation system concepts and new activities relevant to the two settings. The results also revealed the agency that was created, and the reflexivity that was revealed as being part of this agency development process. Substantial knowledge was generated through this process with regard to expanded understanding of communal irrigation management, its meaning and the implications. As shown in this chapter, learning is contextual for each case study. I therefore conclude that there is need to situate learning according to the specific contextual histories of the community-based irrigation systems and the associations involved in implementing this policy. I also conclude that the learning processes that emerge, differ in diverse contexts of interventionist research. Intervention CLWs produce discontinuities with the historical forms of learning associated with irrigation system development. There are also generative mechanisms that act on the learning and its emergence, and these are dependent, to some extent, on the context of irrigation system development. Inferences related to generative mechanisms and causal powers of learning are discussed in the next chapter.

CHAPTER SEVEN

Concluding the Study: Transformative Social Learning and Sustainability in Community-Based Irrigation Scheme Development in Mozambique

7.1 Introduction

This study's key aim was to understand transformative social learning within the development of sustainable irrigation practices in the context of irrigation associations and new agrarian policy and development in Mozambique. As mentioned in Chapter One, this study sought to examine how transformative social learning has (or has not) emerged in existing activity systems in the two case study sites to date (Goal 1). These insights were reported on in Chapters Four and Five. Based on this understanding, the study then set out to examine how transformative social learning could emerge through expansive learning processes (Goal 2) which took place via identification of contradictions and engagement with new solution modelling with the two irrigation scheme communities. The insights gained here were reported on in Chapter Six. In this chapter I examine in more depth the potential opportunities for ongoing transformative social learning in both the Macubulane and Massaca community-based irrigation associations (Goal 3 of the study), which also concludes the study.

In the previous three chapters I discussed evidence of existing and expansive learning, mainly at the levels of the actual and empirical in the two case study sites. In both chapters, there are also pointers to ongoing potential for transformative social learning, as shown, for example, in the expressions of agency analyses in Chapter Six, and in the ongoing engagement with contradictions that are emergent in and between the activity systems described in the previous chapters. In this chapter I deepen the analysis by including a consideration of both nominal and real absences – to identify further possibilities for ongoing transformative learning in the two case study sites, and in relation to the implementation of the community-based irrigation system policy in Mozambique more broadly. Developing insight into the generative mechanisms and absences at the level of the real, assists with producing tentative 'generalisations' at the level of the real (Danermark et al. 2002) which can help to inform wider initiatives to support transformative social learning with not only the two community-based irrigation schemes under study in this thesis, but potentially also more widely; hence I also make recommendations for curriculum development and for wider application and use of the model of transformative social learning in the irrigation scheme development context.

In section 7.1 I begin with a discussion on the absences (both nominal and real) that exist in the social learning processes and irrigation practice contexts. Next, in section 7.2, I consider how the absences can be absented through ongoing dialectical transformation possibilities, highlighting the potential for ongoing transformative social learning. I then proceed, in section 7.3, to examine the potential for transformative social learning in the context of sustainability. Following this, I interpret generative mechanisms that are shaping transformative social learning potential in irrigation systems (section 7.4), before analysing some of the dilemmas of learning and agency in irrigation associations (section 7.5).

In section 7.6 I propose a model of transformative social learning in irrigation associations, and make recommendations for further testing and use of the model in future research and praxis. Section 7.7 considers recommendations for curriculum and policy development to strengthen further transformative social learning in community-based irrigation scheme development. Section 7.8 concludes the study with a brief synthesis of the main contributions to knowledge.

7.2 Absences in the existing social learning processes and irrigation practice contexts

Bhaskar (1998*)* claimed that "dialectic is at the heart of every learning process" (p. 40)*.* Considering this, I explain the learning processes in this section using the concept of dialectics based on dialectical contradictions and absences in the irrigation system as a source of transformation. As noted in Chapter Two, Norrie (2010) defined dialectical contradiction as "a form of internal contradiction where a thing, idea, or practice discloses an internal, or intra relationship with something else" (p. 70). According to Bhaskar (1998), absences play a role in the identification of entities and the identification of things is a human act. Bhaskar argued that objects can be grasped by reflecting on what they are not, as well as on what they are. These arguments concern the role of absence in the (epistemological) act of identification, the (ontological) constitution of objects, and in (practical) causal changing of such objects, in the case of this study via the expansive learning processes reported on in the previous chapter.

Bhaskar (2008) argued that the category of absence is vital to 1M–4D links in dialectical critical realism (see section 2.5.5). Thus, a 1M non-identity may generate a 2E absence, causing a 3L alienating "detotalisation" or split-off, resulting in a potentially transformative "totalising praxis absenting the split" (ibid., p. 39). 2E absence "is the key mediation between 1M non-identity, 3L totality and 4D agency, which has as its prototype, the absenting of absence manifest in the satisfaction of desire" (ibid.).

As explained in Chapter Three, this study focusses on learning in community-based irrigation systems through a process that involves the absenting of absences. As shown in previous chapters (Two, Five and Six), irrigation activities include the intake of water from river basins and allocating it to the field, monitoring the water supply and quality, maintaining canals and equipment, and controlling weed and fertiliser. These tasks are comprised of hardware and software. The software is concerned with management processes and the hardware includes all infrastructure and equipment. While in the process of running the system (i.e. crop production, operation and maintenance), contradictions or constraints or absences are expected to occur, while irrigators try to fulfil the objectives of the irrigation system, some of which have been reported on in Chapters Five and Six. If the broad objectives of the irrigation system are not yet attained, constraints and absences are continually identified and absenting these involves a complex process of learning to eliminate those constraints or absent the absences (Bhaskar, 2008), a process which allows emergence and potential transformation and sustainability of the system.

The process of absenting absence starts with the identification of absences in the irrigation system. Absences are geo-historically and socio-culturally informed and shaped, thus, absences are being identified in different learning cycles in the association, which include:

- daily meetings within the management board;
- meetings with the extensionists;
- meetings with local authorities;
- meetings with irrigation agencies;
- meetings in the wide-range assembly; and
- formative intervention research meetings.

These meetings, while also being a source of absence identification, are also a source of learning in the community-based irrigation system. Bhaskar (2008) stated that "in real science, individuals, particulars and universals are always already known under some more or less precise description, tied, when existential questions become pertinent within the specific context of inquiry, to definite demonstrative and recognitive criteria of existence – which they may simply fail to satisfy" (p. 40). He further argued that fallibilism itself depends on the idea of identifying and remedying mistakes. This means that the success of learning for transformation is likely to, at least partially, depend on the identification of absences in the irrigation system context, and subsequent processes of absenting these absences.

Following the interviews, observations and change laboratory workshops (reported on in previous chapters), I identified and summarised several absences in both irrigation systems which are presented in Table 7.1. These absences are identified in the ontological levels of the empirical and actual (see section 2.5.1) and I refer to these as nominal absences. Collier (2001) drew attention to the difference between real and nominal absences, with nominal absences being those that are easy to see 'all around us', and real absences being more difficult to identify as they are related to often invisible but real structural generative mechanisms and tendencies (e.g. global capitalist structures holding structural inequalities in place). The coding A1, A2 etc. in Table 7.1 refers to different nominal absences and I indicate in which case study site the nominal absences were found (Macubulane or Massaca or both).

Based on my readings of absence in the work of Bhaskar (2008), and in the context of this study's core interest, I defined absences in terms of learning inference categories that may be explained as constraints in understanding, inconsistencies, incongruences, and unmet needs. These are related to, and are causal to some of the contradictions identified in the previous two chapters, and are also generative of some of the transformative learning processes already identified in previous chapters. Here I show that learning absences can also be seen as generatively causal to the emergence of tensions, contradictions and problems found in the community-based irrigation activity systems in this study, and that there are real absences which are also causal to these more nominal absences.

7.2.1 Nominal absences observed in the co-management irrigation systems

Table 7.1 below presents the nominal absences that I could identify in the two irrigation associations. I also consider the reasons for these absences, and the implications thereof.

Table 7.1: Absences interpretation in both irrigation systems

Absence - A	**Absence**	**Reason for absence**	**Implications**
A1 – found in both cases	**Absence of adequate knowledge** and understanding of key concepts associated with irrigation management reflected in limited interpretation of the concept of (i) irrigation system, (ii) irrigation management, and (iii) irrigation association. This became apparent when participants were asked about the meaning of these concepts (see sections 6.2.2 and 6.5.2). There is a lack of understanding of the concept of irrigation system management.	Limited / absence of good quality descriptions and definitions of concepts in mediation tools and artefacts on irrigation system management, both in terms of knowledge and practices. This is linked to limited syllabus content focussing on establishing community-based irrigation associations, especially for agrarian associations associativism (irrigation associativism and agrarian associativism or being in an association or cooperative). Available syllabus on irrigation does not discuss the process of management of irrigation.	Immediate implication: the absence of this concept reflects in (i) complications in operating and managing all systems; (ii) irrigation efficiency; (iii) irrigation management performance; and (iv) active involvement of farmers. A relevant issue was that learners did not clearly understand the object of the irrigation association. Although they have an approved status as irrigation association, participants in the study (co-learners in irrigation system management change laboratory workshops) did not know the rights and tasks involved in the irrigation association. Unclear roles in the process of management and division of labour, low productivity.
A2 – mainly in Massaca case	**Absence of new irrigation-based practice,** reflected in farmers still using rain-fed farming practices and with limited knowledge of the irrigation system, e.g. they still grow cassava (which does not require too much water and takes nine months to grow), use traditional alignment or compass in cropping or seeding, and did not accomplish crop water requirements (see section 5.3).	The process of internalisation of new knowledge on irrigation practices is still not satisfactory. The concept of irrigation system is concerned mainly with a commercial perspective. For farmers, subsistence cropping practices were uppermost in the minds of most farmers due to previous cultural knowledge and experience. Deficient water allocation in the field; use of inappropriate rules.	Low productivity; farmers start to have difficulties paying irrigation fees.

A3 – Macubulane Case	**Absence of convenient access at regular intervals** Limitations in following the irrigation schedule and weed crop control.	In the case of operating the sprinklers, farmers were unable to come to the field at least three times a day.	Low yield affecting the whole association. Some plots are affected by weeds, which influences the production of sugar cane. This lowers the total revenue of the association, affecting all members.
A4 – Massaca case	**Absence of regular technical maintenance leading to absence of regular water supply** In the case of the Massaca irrigation association, there are a few abandoned plots and a dysfunctional pump system.	Water did not reach specific plots, mainly those plots that are far from the head of hydrant. Land-based associates in Massaca irrigation association, meaning the plot is guaranteed even if it is not being used. Due to intensive use of soils some plots were affected by salinisation, reducing the yields. The association is still not using appropriate rules. In some plots, soils consist of heavy rocks in the field so farmers are unable to explore and use all the available area.	Water dispute amongst farmers that have access to the water and who block the canal for others. Invasive plants from abandoned plots spread to the neighbouring fields, sometimes affecting the yields of producing plots.
A5 – mainly in Massaca case but also in Macubulane in the early stages	**Absence of irrigation efficiency management practices** Low efficiency related with higher loss of water in irrigation system. In the case that water is supplied following the irrigation schedule, there are farmers that do not use the system, as they are not available for farming, or in cases where the plots have been abandoned.	With gravity irrigation, water is delivered to the perimeter from the head, but when farmers are not in the field to use it, the water runs without being used and power is wasted. There is a lack of understanding of the concept of irrigation efficiency and conflicts exist in terms of the principles of irrigation systems (e.g. cost recovery). Inappropriate maintenance of the system (e.g. canal, equipment) which is partly due to an inadequate budget resulting from farmers not paying their fees.	Low irrigation productivity, reduced efficiency.

A6 – Massaca	**Absence of commitment to the collective association's rules of operation** Farmers do not pay water fees. Another disturbance has to do with the weak participation of the members during the general assembly.	Some farmers argue that they do not receive water so they do not pay their fees. Farmers did not understand the reason for the meetings.	Low yields. For example, because of water shortages, farmers do not receive water because of damage to the pump system. As an implication, the association fails to pay their electricity bills, and many plots will not be irrigated. As a result, the management board made decisions themselves at their own risk.
A7 – Macubulane and Massaca	**Absence of regular income** Limitation in the fulfilment of social needs. Members also have plots outside of the schemes and they practise rain-fed agriculture (mainly cassava and maize) during the rainy season from October to February. In the same period, they also plant the same cultures in the irrigation system.	Sugar cane grows in nine months and the harvesting is done once a year, which means that the members get money once a year, when the sugar cane is sold to the sugar cane company. The money is not enough to support their needs during the whole year or until the next harvest. Need for additional income, fulfilment of diet.	Unmet needs. Irrigation fields abandoned. During harvesting time, the market might be flooded with particular products.
A8 – in both sites	**Absence in coherence between knowledge and action** Dissonance between what farmers know and what they practice.	Farmers are not using appropriate knowledge and this is reflected in the outputs, quality and conditions of crops that are being produced, which do not correspond with the purpose of the irrigation system.	Low productivity.

Table 7.1 shows that it was possible to identify a number of nominal absences which are related to an absence of sufficient knowledge on processes of using and managing the irrigation system and absences interpretation in both cases, as well as an absence of sufficient knowledge on how to maximise the potential profitability and harvest potential from using a diversity of crops, efficiency measures, and sustainability measures to improve harvests and productivity (A1, A2, A4, A5 and A8). Absences are, however, not only related to the absence of sufficient knowledge, they are also related to

an absence of alignment of the irrigation scheme practices with the realities of the socio-economic conditions and lives of the farmers as shown in A3 and A7 above. These were related to physical convenience and possibilities for participating in the irrigation scheme (A3), as well as the economic demands and realities of living close to the poverty line (A7). All the absences identified in Table 7.1 result in low irrigation productivity, reduced efficiency, reduced environmental sustainability, and unmet needs. *Absenting these absences are therefore core to transformative social learning processes in the emerging community-based irrigation scheme systems.* Giving attention to the real absences may provide further insight into the potential for extending transformative learning approaches in the community-based irrigation scheme systems.

7.2.2 Real absences identified in the two case contexts

In this section I discuss the real absences (RA) that I could identify in the two case studies using retroductive analysis which helps to ask the question "what would, if it were real, bring about, produce, cause or explain a phenomenon?" (Bhaskar, 2016, p. 3). I identified three major real absences which appear to be influencing and shaping the nominal absences. These real absences relate to underlying generative mechanisms of the socio-economic conditions of poverty, values and norms, and quality of education and training, and how these intersect in both case study contexts.

- **RA1: Absence of adequate safety nets / income security for people emerging out of poverty**

As mentioned in Chapter One, the Mozambican policy of supporting farmers to move from rain-fed to community-based irrigation systems is aimed at ensuring that farmers may overcome being victim to ongoing cycles of poverty. As discussed in Chapter Four and Five, this was also a key expectation among farmers. As shown in Chapter Four, as farmers in Macubulane became engaged in sugar cane plantation via the community-based irrigation scheme development, farmers tended to leave, at least to some extent, previous practices of rain-fed food production. As reported in Chapter Four, revenue from sugar production was only paid out once a year and it seemed to be too little for their annual needs, because most farmers were only producing on one hectare of ground. In the case of Massaca irrigation association, there were also problems with regular financial flows from the new type of community-based irrigation scheme development, as markets were flooded with particular produce at certain times of the year, offering smaller returns on production investment than were expected. In both cases, these issues left farmers with income insecurity, and the promises of addressing the poverty cycle problem via the irrigation scheme development were not met. This problem can be traced back to the confluence of inadequate knowledge and support for maximising the scheme's productive potential, but also to the wider context of an absence of adequate safety nets or basic income security for people who are emerging out of poverty. This, as shown in the previous two chapters, threatens the success of the new policy. *Thus, to absent this absence, it would seem there is a need for policy intervention that combines the new scheme development processes with adequate knowledge and support, which should be inclusive of a safety net system for people emerging out of poverty. Transformative learning and sustainability should therefore encompass both the knowledge problem, but also the wider need for policy intervention to more adequately support people emerging out of poverty.*

- **RA2: Absence of new collaborative norms and values implied in the policy**

As shown in Chapter One, the policy assumes a collaborative approach to implementation of the irrigation schemes amongst communities emerging from poverty. This collaborative approach is not at household level, but at community level, and therefore requires collaborative norms and values, as well as practices which are different from those that were operating within the rain-fed agricultural system. The new system required new collaborative norms related to financial co-management, technical co-management, and land-use co-management, as well as development of shared economy principles. As reported in Chapters Four and Five, these new collaborative norms and values were yet to be fully established. For example, in the Massaca irrigation association, plots were abandoned showing weak collaborative norms, policies and rules. Production plans did not link with market plans, and it was found that farmers produced similar products that were being produced by others in the rain-fed agricultural system, and consequently the market became flooded with the same products. Unused plots also caused wastage of water that was supplied to the perimeter, and wastage of power that was used to supply that water, creating costs and water fees that were unsustainable. In the case of the Macubulane irrigation association, farmers of sugar cane hardly understood sugar markets, or the complexities of how the incomes were distributed once per annum, despite having developed some structures and organisational principles over time to work more effectively together. *Thus, to absent this absence, it would seem transformative learning would need to focus not only on the absence of knowledge of the concepts, practices and technologies, but also on the need to develop and strengthen new collaborative norms which extend to principles of a shared economy.*

- **RA 3: Absence of relevance in the education and learning system to policy and context at the level of community practice**

As indicated in Table 7.1 above, a key nominal absence in the study is adequate knowledge of the new irrigation system practices, and management of this type of community-based irrigation system. The absence of adequate knowledge was noted across Chapters Four, Five and Six as an impediment to the development of the community-based irrigation schemes. Empirical data in the study reported in Chapters Four, Five and Six has also pointed to some of the causes of this. For example, the curriculum of the Agrarian School in Boane District and tertiary schools in the area show an absence of engagement with community-based irrigation policy, system and practice knowledge, and management practices for this approach to farming, including knowledge of ecological sustainability principles and development of collective norms and values. Further empirical evidence in the study points to the fact that although there are some initiatives for introducing internships as a situated approach to strengthening agricultural education and training, it was said that these internships were still too short with not enough time in the field, with the result that students could not follow the entire crop production cycle. *Overall, this points to an absence of contemporary policy and practice relevance in the agricultural education and learning system, especially as applied at the level of community practice. Absenting this absence would require curriculum development that would a) incorporate community-based approaches to irrigation scheme practice and management, and b) provide applied relevance and experience for students. Such a curriculum development process would need to take account of transformative social learning potential as outlined in this study, which responds to both the nominal and the real absences identified, and the issues associated with transformative social learning as experienced by farmers in the field.*

7.3 Engaging contradictions and absenting absences via dialectical praxis formation: processes of transformative social learning

Bhaskar (2008) stated that dialectic depends upon the positive identification and transformative elimination of absences, i.e. the process of absenting absence. This process involves absenting or negating an existing state of affairs (Norrie, 2010). Change can be analysed in terms of absenting the previous state of affairs in favour of the new state of affair (ibid.). Absences exist and operate at the level of epistemology, meaning the identification and elimination of mistakes is important for creation of knowledge. Moral praxis includes the identification and elimination of constraints which is key and the identification and understanding of absence are central to Bhaskar philosophy. The process of absenting absences in the irrigation systems of the two case studies can be described in context of (i) absenting absences through workplace learning (as shown in Chapters Four and Five); (ii) absenting absences through a social leaning process (as shown in Chapters Four and Five); and (iii) absenting absences through formative intervention workshops (Chapter Six); with further potential for absenting absences through (iv) curriculum development (which I discuss in more detail in section 7.7 below).

As shown in Chapters Four and Five, in the formation of community-based irrigation associations, absenting appears to be central to a basic human cognitive process in which irrigators, after identifying and examining the causes and effects of absences, learn to overcome the previous state of affairs. Here, it is important to recall that Bhaskar (2008) argued that an absence is intrinsic in developing or becoming, and in Engeström's cultural historical activity theory, he considered absenting contradictions via new solution modelling and transformative agency development as intrinsic to the formation of new human activity, which is also a dialectical process of development or individual and collective becoming (not unlike Bhaskar's proposal for dialectical transformation). As Norrie (2010) noted, "Bhaskar argues that any causal determination, hence change, is an example of transformative negation or absenting – that is, it absents what was previous there, in the formation of what now exists" (p. 36). Thus, change absents or negates the previous state of affairs or entity (ibid.). A practical perception of absenting absence in irrigation systems, based on the data presented in Chapters Four, Five and Six is presented in summary in Table 7.2 below. The practical perception of absenting absence broadly follows Bhaskar's dialectical model for transformative praxis (see Figure 7.1 below), in which he sees learning as key to the transformative praxis process. Bhaskar's (2008) ontological changes require practical agency (i.e. a focus on constraints of knowledge), which entails moral and epistemological knowledge that informs the absences. Absenting absences implies agency, as also shown in Chapter Six of the study. Such agency, according to Bhaskar, involves a pursuit of a sense of freedom i.e. to absent those ills that are affecting one's well-being, and to carry this through at the ontological level to real freedoms, requires praxis (i.e. application of skill, establishment of appropriate practices in context) i.e. theory and practice-in-practice as this manifests in the co-creation of the transformed object of activity. It also involves rational and reflexive understanding of the changes in the bringing about of the preferred changes by those involved, in the case of this study, the members of the community-based irrigation associations and affiliated members of associated activity systems that they interact with.

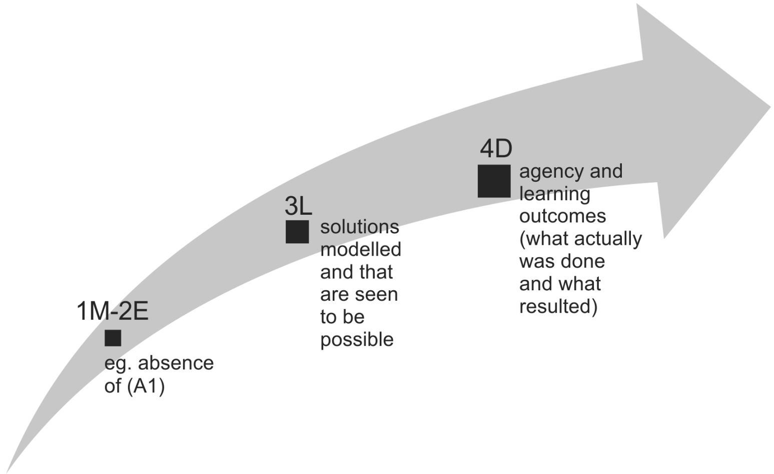

Figure 7.1: Bhaskar's dialectical model of transformative praxis

Table 7.2: Summary of the dialectical transformative social learning process as identified across the case study sites

1M-2E: Existing situation with contradictions and absences	3L: Transformative Social Learning; solutions modelled that were seen to be possible; emergence of agency expressions	4D: Agency and outcomes (what actually was done and what resulted)
Macubulane: Summary of contradictions 1. *Between mediating tools and subjects* – related to inadquate understanding of the irrigation system 2. *Within the mediating tools* – inadequacy of the intership programme length 3. *Between rules and subjects* – related to inadequate knowledge of what to do in the association 4. *Between rules, subjects and mediating tools* – related to the payment of taxes 5. *Between rules and subjects* – related to lack of clarity in management roles of the board	Extend internship from one month to three months in order for learners follows the whole cycle of crop vegetative growth Provide training on how to produce vegetable crops efficiently Redefine activities and focus (see Figure 6.3) Discussion with agrarian school regarding further process of internship	Recognition of internalisation of the concept of Irrigation Management and challenges of running it Development of new activities (see Table 6.6) Training was provided by CIDAE for vegetable production The farmers are now producing vegetables in available land at Macubulane Establishment of clinic Increased and stabilisation of yields (see also Figure 6.3)

6. *Between mediating tools and subjects* – related to activity planning 7. *Between object and mediating tools* – related to need for better irrigation planting 8. *Within rules* – related to use of loan funding 9. *Between subjects and rules* – related to management of loan funding		
Massaca: Summary of contradictions 1. *Between mediating tools and object* – related to the water provisioning 2. *Between mediating tools and division of labour* – related to the fact that some members do not plough the plots 3. *Between rules and the object* – related to practising of rain-fed approaches in the irrigation system 4. *Within the object* – relates to the taxes levied on water 5. *Between rules and object* – relates to farming in and outside of the irrigation scheme 6. *Between rules and subjects* – relates to non-application of new knowledge from extensionists 7. *Between mediating tools, rule and subjects* – relates to efficacy of farming practice and association management decision making 8. *Between mediating tools and subjects* – relates to externalities	Agreed to increase in water fees Started discussion for a new irrigation project with CIDAE See also Table 6.7	Implementing new farming approaches using water from the irrigation allowed for increase in yields for those who were active in the irrigation-based production system. Creation of new tasks and rules for managing the hydrant, and for allocating the land, improved the management approach. Sharing knowledge of suitable crops See also Table 6.6.

In both cases: nominal absences 1. Absence of sufficient knowledge and understanding 2. Absence of new irrigation-based practice 3. Absence of convenient access at regular intervals 4. Absence of regular technical maintenance 5. Absence of irrigation efficiency management practices 6. Absent of committment to the collective association's rules of operation 7. Absence of regular income 8. Absence in coherence between knowledge and action	Started understanding and reading themselves about expanded concept of irrigation system anad managment Acquisition of new equipment Hiring of workers from community See Figures 6.3 and 6.7	Concept formation included emerging understanding of the concept of irrigation systems and management, which can be described as a socio-ecological system, relying on interconnected sets of activity systems, and understanding of how to operate the irrigation system to achieve sustainability. Loan scheme improvements to deal with absence of regular income. See also Tables 6.3 and 6.6
In both cases: real absences 1. Absence of safety nets 2. Collective production / shared economy values and norms at community level 3. Relevance of education and training	Proposed diversification of crops and agricultural strategies to ensure diversification of income, and more regular income flows; higher levels of inclusion of women and alternative labour to support production systems and extend household income earning via participation in the collective system of activity. Implementation of an improved loan scheme. Revision of, and creation of new tasks and rules to strengthen collective management functions; re-framing role of general assemblies and market dynamic analysis and planting of irrigation crops that were different to rain-fed crops in the wet season, in response to market demand, and to avoid duplication, thus also opening up new income streams. Proposed a range of courses that were needed and an improved internship programme.	Some diversification of income was achieved, but the full scale of income security and policy related safety nets were not achieved. Improved practice was learned through workplace learning and informal social learning and extension support. Improved conceptual development was achieved via the expansive learning intervention workshops, as well as solution modelling and commitments to collective change practices. Wider curriculum transformation in colleges and universities was not achieved.

From the descriptions in Chapters Four, Five and Six, the dialectical learning process took place via workplace learning where farmers learned via ongoing problem solving; via social learning which occurred via reflective and reflexive engagement with their practices and support provided by external agents such as extension services; and via formative intervention workshops (CLWs) which deepened reflexivity and allowed for more conscious forms of solution modelling. These three forms of transformative learning allowed farmers to begin to address contradictions, as well as nominal and real absences, as can be seen above in sections 7.1.1 and 7.1.2.

However, there were spheres where farmers' own situated workplace and situated social learning processes could not begin to address the wider policy related and curriculum related concerns. To some extent, the expansive learning workshops reported on in Chapter Six allowed for these issues to be surfaced, but as noted, it was also difficult to fully address these issues. As can be seen from the evidence in Table 7.2 above, and from the preceding three chapters, the emergence of the transformed object of activity – from rain-fed to community-based irrigation scheme development – was, in effect, also a complex, dialectical and emergent process of transformative social learning.

This study shows that such learning is never 'one specific thing' or 'one type of intervention', but rather that transformtive social learning involves an ongoing reflexive and emergent process of engaging with contradictions and absences emerging from and relating to the object of activity at the level of the real, actual and empirical. As discusssed in Chapter Three, according to Engeström (1987), learning activity is a transitory, intermediate kind of activity between science and work that includes reflecting and reformulating current irrigation practices and performing actions for change in irrigation associations. Engeström (2009) importantly noted that activity theory is a theory of object-driven activity. Objects are concerns and through activities, people constantly change and create new objects. However, it is important to note that "the new objects are often not intentional products of a single activity but unintended consequences of multiple activities" (p. 304), as can be seen from this study and the formation of the community-based irrigation system object of activity. Engeström (2008b) defined a type of 'runaway object' as an extreme form of contested object that generates opposition and controversy. Such objects tend to be either associated with natural forces (diseases, environmental threats) or with rapid technological innovations. In this study, I did not work with the concept of 'runway objects' while moving from rain-fed to irrigation system practices, although more in-depth engagement with the longer term consequences of climate change in the community-based irrigation system could potentially re-frame the object in the direction of a 'runaway object'. For the scope and purpose of this study, this was, however, not relevant.

Engeström (2008b) also noted that in expansive learning one of the objectives is a re-mediation by creating new theorectical concepts that serve as "germ cells" for expanded horizons of possibility. Davydov (1990) stated that the roots of theoretical generalisation are in our primordial attempts to change our conditions and to experiment with new solutions. In this study, I concentrated on expansion of "germ cells" as used in the CHAT literature, by expanding concepts, as described in Chapters Four, Five and Six.

Engeström (2009) further noted, as also shown in this study, that "the societal relevance and impact of activity theory depends on our ability to grasp the changing character of objects" (ibid.). As also shown in this study, transforming an activity is a process that requires a kind of collaboration that goes beyond established boundaries (Kotter, 1996). Engeström (2008) stated too that new objects are formed, not as intentional products of a single activity, instead, they are most often a coming together, or consequence of multiple activities and new concept formations.

In the case of this study, it is possible to see that the new object of community-based irrigation system management requires a coming together of a range of different activities such as new farming practices, collaborative management of an association and its rules, relevant education and training, and establishing viable income streams for farmers and formation of the new concept of associative irrigation system farming. All these form part of the transformative social learning system that I have been able to probe and describe in this study from an existing (Goal 1), expanding (Goal 2), and potentiality (Goal 3) perspective. As shown in this study, and in my understanding, *either contradiction, dissonance and/or absences are to be considered critical for* transformative social learning *in the context of the emergence of community-based irrigation system development.* Should I only have focused on contradictions, I would not have been fully able to consider the real absences which are generative of some of the nominal absences and the contradictions that were identified. These, together with the object of activity, form the zone of proximal development for community-based irrigation scheme development. I provide a summative view of the zone of proximal development for community-based irrigation scheme development and transformative social learning, as observed in this study (see Figure 7.2 below).

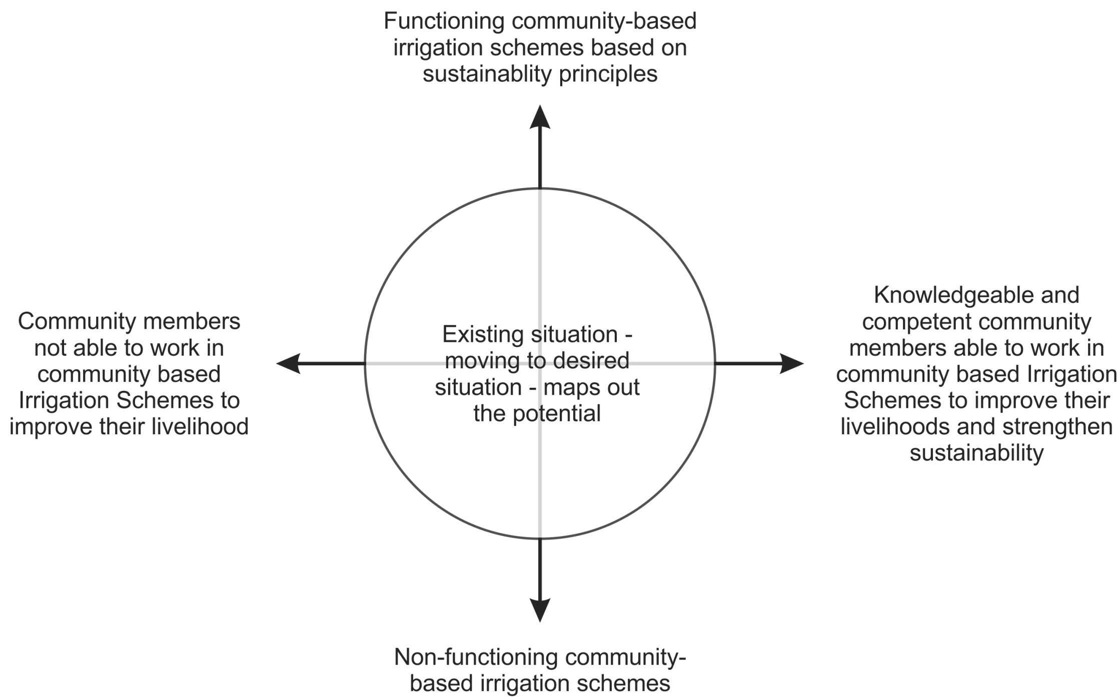

Figure 7.2: System of addressing contradictions and absenting absences in a zone of proximal development for community-based irrigation scheme development in Mozambique

Engeström (2011) argued that the theory of expansive learning places emphasis on communities as learners, on transformation and creation of culture, on horizontal movement and hybridisation, and on the formation of theoretical concepts. As shown in this study, via the expansive learning process, participants learned new things in response to contradictions and absences, all of which contributes to the building of the new object and its realisation in practice. What the study was not able to do, however, was to fully engage the curriculum and policy activity systems in relation to the formation of the new object; yet these activity systems appear to be critical to the full realisation of the new object's formation (i.e. the community-based irrigation scheme development).

Figure 7.2 above provides a broader summative 'view' of the ZPD directionality associated with the new object's formation. It is derived from findings relating the more case specific mapping of the Zones of Proximal Devleopment in the two case sites, depicted in Figure 6.3 for the Macubulane case and in Figure 6.7 for the Massaca case. Figure 7.2 therefore provides a broader 'directional' learning map depicted through grouping direction movments in the ZPDs which may allow for transformation, providing a broader view of the ZPD associated with the transforming object across the two cases. It shows the fuctional direction to achieve shared goals in the emergence of community-based irrgation systems and generative mechanisms.

It is particularly at the level of the real generative mechanisms where these institutions (policy and curriculum development institutions) operate, that it is difficult to establish transformative praxis in community-based irrigation system settings, especially with regard to those aspects of practice that rely on wider systemic policy or curriculum changes. The analysis in Table 7.2 above shows that, for transformative praxis to be more fully realised, especially in relation to the three real absences identified, there is need for policy and curriculum development interventions (see section 7.7 below), in addition to ongoing field-based transformative learning praxis that develops collective norms and values situated within the transforming object of activity. Policy and curriculum development interventions can therefore also become part of the collective ZPD depicted in Figure 7.2.

Another factor that is related to the the norms and values that are situated within the transforming object of activity, as also surfaced in this study in Chapters Four, Five and Six, is the issue of sustainability. I discuss this next before making recommendations.

7.4 Potential for transformative social learning in terms of sustainability

Social learning processes do not only involve more immediate responses to contradictions and absences, but also require reflections on long-term processes and more deeply seated contradictions and absences, as pointed to above in the discussion on real and nominal absences. In the context of community-based irrigation scheme development, long-term processes are, for example, related to socio-economic concerns such as poverty alleviation (as noted via RA1), changes in cultures (as noted via RA2), and institutional norms and practices (as noted via RA3). However, there are also long-term processes that are related to social-ecological system sustainability, and in this study, these have emerged in the form of the need for pre-season checks, soil salinisation and soil management, reduction of water wastage, and disaster risk reduction and management related to floods, extreme weather events and climate variability which affects farming productivity. Given that sustainability, as discussed earlier in section 1.7.5 involves giving attention to relationships that exist between the social, ecological and economic. The longer term concerns which also emerged in the form of real absences, point to sustainability overall also being potentially considered as a real absence (RA4). As pointed out by Lotz-Sisitka (2016), sustainability is yet to come into being, at present it is absent everywhere, despite social movement *towards* sustainability, and is therefore an important dimension of conceptualising zones of proximal development for transformative social learning. In this regard, Wals (2007, p. 23) argued that,

> … social learning processes often take a long time and require much dialogue. People are often enthusiastic, especially at first, and they want to get started quickly and proceed to take action. Still, it is usually wise not to think in terms of solutions and perspectives of action straight away, but rather to first carefully determine what the problems are exactly and in which direction we would like to go together. This necessary step can frustrate as the participants may feel that they are not making progress.

However, dealing with sustainability issues in the emergence of the community-based irrigation scheme development is a complex issue, as shown by this data extract, and the subsequent discussion on farmers' perspectives on sustainability in the context of developing the community-based irrigation system object:

> **Respondent FGMB4***: In irrigation land the same plot, I divide it and produce beans, tomato etc. Depending on the period when it's difficult to produce in the rain-fed land, then I get much profit from the irrigation system. In rain-fed land I used to crop maize, cassava, sweet potatoes for consuming.*

This extract shows that the change in practices may be less sustainable from a household food security and production diversity point of view, but potentially more lucrative from an economic point of view.

While sustainability is a complex issue as shown above, sustainability learning in irrigation systems is also a crucial issue and during the research, I asked farmers what they understood by sustainable irrigation, as shown in the data extract below:

> **Data extract from the Macubulane irrigation association focus group interview (13 December 2012)**
>
> **Respondent EDAMM5:** *Sustainability means doing things well in such a way that we produce what we think is supposed to achieve.*
>
> **Respondent EDAMM1:** *Means work well and get healthy.*

This extract is one of many examples that demonstrated that there is very limited knowledge of the concept of sustainability amongst farmers (see also the data shared in Chapters Four and Five), for example, it was only through the focus group interactions and CLWs that farmers were able to develop a broader and more integrated understand of sustainability in irrigation associations to include: (i) learning to improve crop productivity (in quantity and quality); (ii) learning to guarantee efficient use of ressources, mainly water, labour and energy; (iii) learning to guarantee environmental quality, such as water and soil systems and farmers' well-being and social improvements; (iv) learning to guarantee efficient use of irrigation infrastruture.

Farmers' conceptions of sustainability were more concerned with productivity and outcome. However, I assumed that a broader concept of sustainability is important to understand the whole irrigation system as a social-ecological system, and therefore opened dialogue with farmers on this in the focus groups and CLWs. The reason for this is that most of the constraints experienced among farmers and relevant actors in the development of the irrigation system practices, can be misunderstood due to a limited understanding of the wider sustainability concerns associated with irrigation system development.

As shown in the data in Chapters Four, Five and Six, learning for sustainability in the irrigation systems of the Macubulane and Massaca irrigation associations is concerned with (i) a technical dimension in terms of capacity, and irrigation practices; (ii) ecological aspects related with environmental risk which affect production (e.g. soil salinity), and (iii) social dimensions related to the welfare of farmers. Sustainability learning in terms of technical concerns can be explained in relation to irrigation farming practices (i.e. monocropping or multicropping), as well as in relation to irrigation methods (i.e. gravity or sprinkler) and if farmers are able to secure markets to sell their products after harvesting (i.e. outsourcing or not). For example, as explained in Chapter Four, the Macubulane irrigation association farmers only plant sugar cane and they have an outsourced marketing system. Including sustainability allows for learning to be mediated in a such way that the farmers can become more resilient and that they can maintain the system within a longer time period focus. As reported in Chapter Five, in Massaca, farmers practised cropping and gravity feed irrigation appraoches which were less resilient from a sustainability perspective. As shown too, the operational costs associated with the sustainability of the irrigation system were also skewed in that the water fees charged to each member of the association did not cover at least the operational costs of the irrigation system, and they did not ensure resource efficiency as there was water wastage.

I also asked farmers about the ecological concerns in the irrigation system, and as reported in Chapters Four, Five and Six, these were mainly related to soil quality, water wastage and flooding, as reflected in these data extracts:

> **Respondent FGMB1*, Massaca association:*** *We have problems with soil salinisation and soil quality. Some of the plots are not productive because of the existence of rocks.*

Respondent CLWMM12, Macubulane association: *The environmental issues are concerned with the sugar cane that grows and produces within five years after which it must be removed. We expect to have problems with soil salinisation due to irrigation.*

Respondent EDAMM6, Macubulane association: *We had problems with irrigation in 2011. We could not irrigate for a month because of floods. The engines broke down and we had to take them to Maputo to get fixed, and the yield reduction was around 82 ton/ha and that happened during the peak of the sugar cane production, so a lot of water was needed to irrigate the fields.*

The extracts demonstrate the ability of the community to identify the main environmental concerns in the irrigation system. The concerns included soil degradation and floods, as well as preparedness to cope with such issues. As shown in Chapter Six, through the formative intervention of CLWs and the expansive learning process, it was possible to discuss environmental risks related to these experienced concerns with soil degradation, flooding and water wastage reduction, with potential solutions to these being proposed and agreed upon. However, this is not always an easy process, and also requires reflexivity and struggle as shown in this extract from the Massaca irrigation association's management board:

Respondent IIMB1, Massaca Management Committee*:* *The management processes are very difficult. Members have different ideas. When we say that the money that we are paying is not enough, they don't understand. We cannot pay the running costs of the irrigation system if they don't pay fees. The farmers say that what they have paid so far is too much and they don't agree. So it is not easy to manage people. It is a bad experience. During the wet season the farmers abandon the irrigation system and go to rain-fed fields.*

This data extract refers to the learning process in the Massaca irrigation association and shows that it did not fulfill the object of the irrigation association, namely to ensure the implementation of wide-ranging deliberation, water fees collection, and guaranteeing efficient implementation of the association's object. Here we can see that the management board is upset by the limited participation of members in the community-based irrigation activities. Related to the same issue is another incident where a Massaca partner did an assessment with farmers to rehabilitate the irrigation system and he suggested that they could pay the cost of the rehabilitation. The condition for this was that the association needed to guarantee the production of a certain yield to that company in order to pay the company back. Unfortunately, the farmers were unable to do so and to take the risk, and they were therefore not able to improve the sustainability practices of the irrigation system.

In the context of the community-based irrigation system development, farmers also had to deal with shocks, for example, when the sugar gets too old for harvesting (i.e. if it is not harvested in time) this has an impact on the productivity or when the flood damaged the pumps, or when the markets got flooded with the same produce. As shown in Chapters Four and Five, these shocks also initiated learning and reflection amongst the farmers, and helped to establish workplace-based transformative social learning processes amongst the farmers. As shown in Chapter Six, the formative intervention workshops where greater conceptual and process understandings were achieved, and deliberations on contradictions could take place. They also allowed for generating transformative social learning pathways amongst farmers, but these were affected by structural realities which they continued to deliberate after the CLWs. The views of Wals (2007) are helpful here, as he noted that in reflexively learning our way to sustainability, learning and reflexivity are more important than ranking and accountability. The importance of processes that allow for shared meaning and meaning-making are critical, and as shown in this study, this includes learning to foresee shocks and solve them as they arise.

Sterling (2010) referred to the need to consider sustainability learning at different learning levels, which denotes a shift from learning (perhaps at the level of the empirical and actual) to a higher order form of learning which involves meta-learning and wider epistemic learning. Some also refer to this as 'deeper learning' (ibid.). I found instances of these types of learning emerging during the study, as explained briefly below.

First order learning is related to changes in cognition dealing with efficiency, doing things better or seeing things differently. In Chapters Four, Five and Six, there is evidence of this kind of learning, which in the context of the irrigation systems and their development, was related to improving cropping activity, efficiency in water use, and increased production outputs. In irrigation associations, associates could achieve this by introducing the knowledge that they had received from extensionists and from attending courses. First order change refers to change within particular boundaries.

Second order learning relates to changes in meta-cognition, examining and changing assumptions, doing better things, which in this study was mostly reflected in the the more complex aspects of the social learning processes and CLW outcomes (reported on in Chapter Six). An example of this level of reflection is contained in this data extracts below, which involve proposing new solutions to complex problems:

> **Respondent CLWMB6, Massaca irrigation association***: During winter in rain-fed fields, it is only possible to crop beans but not maize, so what we can do in winter is to produce maize in the irrigation system and avoid concurrency with beans, and we can have much profit with maize.*

> **Respondent CLWMM4, Macubulane irrigation association*:*** *In the beginning it was difficult to understand each other. When we had problems with farmers regarding that we need to buy our own equipment, rather that renting it. Some did not understand, but we decided to buy it and it reflected the benefits in individual incomes. This is when farmers applauded the initiative.*

The second order of change entails significant change in thinking, or what one is doing as a result of examining practices, assumptions and values. This type of change is recognised and exchanged amongst those involved, which I found to be more common in the processes of discussing the irrigation scheme *management* issues. The extract above shows that the farmers started thinking about the added value of irrigation and how they could more strategically use the system. This type of learning influenced changes in the collective practices of farmers, such as changing existing production plans, and sharing ownership of assets, resulting in new possibilities for the irrigation associations, rather than simply repeating practices or reproducing problematic practices. This seems therefore to be an important type of learning for community-based irrigation scheme development. As Wals (2009, p. 9) also stated: “A reflexive society refers to a society that has the capacity to lay existing routines, norms and values on the table, but that also has the ability to correct itself. A reflexive society requires reflexive citizens who critically review and alter everyday systems that we live by and that we often take for granted. Individuals and the group as a whole are willing to take risks.”

Third order learning proposed by Sterling (2010) involving epistemic changes, was mostly reflected in the change laboratory workshop where there was direct intervention to facilitate engagement with complex contradictions amongst multiple stakeholders. As shown in Chapter Six, this is also when participants started to see things differently, and when the discussions centred more on the process of enabling and ensuring more sustainable irrigation systems, the core concepts needed for irrigation system development, and the values that are related to innovative irrigation management practices. It is also here where expressions of agency emerged in relation to these understandings. The extract below illustrates some of the qualities of this kind of learning:

> **Respondent CLWMM, CLWMM6 irrigation association*:*** *Even in our family, we learn how to manage our own food, in order not to run out before the end of the month. Not only that, but we also learn that we need to save some money for the future. … When we employ new outside workers in the association, we feel that we are helping unemployed people.*

This, together with other similar evidence of learning presented in Chapter Six, shows that farmers in expansive learning CLW settings, have the skills to reflect on more complex epistemic and sustainability issues such as the need to understand how individuals work within the context of the association and what advantages there are to working as an association (e.g. shared risks, shared costs, less impact to each individual member, and higher productivity). In the case of the extract above, farmers were able to show that while contracting outside workers from the Macubulane community, they are also helping community members surrounding the irrigation system, meaning that they are practising solidarity, which as shown here, becomes an additional motive in the emergence of a more sustainable irrigation system. This type of learning therefore also seems to be significant to the development of community-based irrigation system development, especially from a sustainability point of view, and while it the first order of learning, as proposed by Sterling, is critical for sustainable irrigation system development, the second and third appear to be particularly important for the community-based form of irrigation system development, and to sustainability thereof in a wider sense of sustainability. In this regard, Berkes, Colding and Folke (2003) referred to the need for adaptive capacity for sustainability, and in such a situation he suggested that sustainability is viewed as process rather than an end-product in order for a social-ecological system to be able to deal with change.

From the above discussion, it is clear there are different dimensions to the question of transformative social learning and sustainability in irrigation system management. These are technical, as well as social and economic. They involve different types of learning (first, second and third order) as per Sterling's description, and they occur in response to contradictions and absences identified in the system. They also involve learning about the actual irrigation system development practices, as well as the management practices, and wider solidarity and ecological system dynamics.

From this, it is possible to distil some **key insights** to guide ongoing transformative social learning in the development of community-based irrigation management associations that also give attention to sustainability:

1. Farmers and irrigation actors, including learning institutions, perform irrigation activities in a better way when they have a common responsibility and that is embodied in collective goals that are contributing to the emergence of the new object of activity, such as increased productivity, maintaining the system, addressing ecological risks, and providing social benefits for the farmers and the wider community;
2. Learning requires a deliberate effort at individual, group, network, and society level that leads to sustainability of the irrigation association. Workplace-based learning, more informal forms of transformative social learning, and formative interventionist change laboratories explicitly directed at expansive learning that addresses contradictions and absences, all offer potential for transforming learning outcomes from individual to collectives and networks; but the latter appears to be more able to elicit higher order

learning as outlined by Sterling's framework, thus contributing more explicitly to transformative learning processes, which also allow for reflexivity and deliberations on modelled solutions and their viability.

3. Learning occurs through a complex range of social learning processes in the development of community-based irrigation systems; highly valued are field-based demonstrations and change laboratory workshops (expansive learning interventions). From all these approaches, farmers acquire benefits in terms of irrigation and management skills to achieve sustainability, with the CLW process helping specifically with collective navigation of some of the more complex contradictions and absences.

And finally, before moving on to a synthesis of the transformative social learning model that I have distilled via this study and final reflections and recommendations, I briefly discuss some factors that affect sustainable irrigation systems. I draw on the work of Abernethy (1994) who suggested that irrigation systems may lose sustainability if and when:

1. The system is no longer able "to deliver the benefits" (p. 138), which I observed in the Massaca irrigation association, which is partly failing because there is no regular supply of water available. This is the biggest concern for people wanting to join the irrigation system. As found in this study, the learning in the association currently, despite the engagement with the expansive learning process, does not yet support transformation that will allow it to overcome the current situation.
2. The system is performing well internally, but it is "injuring other interests" (p. 138). I did not find this threat to sustainability in either the Massaca or Macubulane cases.
3. People no longer want to "devote necessary efforts to key activities" (p. 139). I found some risk of this in the Massaca irrigation association development.

These risks are also important to consider in possibilities for ongoing transformative social learning and sustainability in the emergence of the community-based irrigation schemes which are the subject of this study.

7.5 Generative mechanisms shaping transformative social learning potential in irrigation systems

As indicated in Chapter Two, there is a distinction between the real structures and mechanisms of the world and the actual patterns of events that these structures and mechanisms generate (Bhaskar, 2008). The real refers to structures and powers of objects, whereas the actual refers to what happens if those powers are activated, such as when the powers of the collective are activated to form an association. Bhaskar (2008) noted that in the social world, the action or agency of individuals or collectives may depend on others, and may be influenced by structural, material and cultural factors that are not always observable. This relational view sustains the role of social learning, but also affects how we think about possibilities for transformative social learning. Realists claim that the world consists of mechanisms not events (i.e. mechanisms cause events), which is why I now turn to a short discussion of some of the generative mechanisms that appear to be causal in transformative social learning and therefore also influence transformative social learning potential in the irrigation settings that are the subject of this study. Bhaskar (1979) claimed that the transcendental realist generative mechanisms may come to be established as real in the course of the ongoing activity of science or in the case of this study, learning. Such mechanisms endure even when not activated. Bhaskar (1998) queried what it means to say that a generative mechanism endures and acts in its characteristic way, and his answer was that it does not mean that a regular sequence of events occurs or is experienced, even though the occurrence of such a sequence may, in special circumstances, provide empirical grounds for the hypothesis of the existence of the mechanism.

From this reading of Bhaskar's work, I propose that generative mechanisms of transformative social learning are those forms of power (including agentive powers), culture, materiality and structure that might be internal or external to that which produces learning events and their empirical outcomes. Bhaskar (1979) explained that powers are potentials, which may or may not be exercised. Tendencies, on the other hand, are potentials which may be exercised but these may not be realised or become manifest in any particular outcome (Bhaskar, 1979). In other words, in irrigation schemes such powers may be related, for example, to trust, transparency, motivation, values, and enthusiasm. For example, if people note that the associates of the irrigation community cannot be trusted, then the members may not be motivated to donate to the irrigation management board, thus impeding the associations' development and transformative social learning potential.

In the social sciences, critical realism considers that reasons may be causes, and in doing this, it possesses a wider conception of causation than is customary, in that it does not assume that all causes must be physical (Bhaskar, 1998). This sustains the existence of social structures that are to be understood as informed from the prevailing mechanisms (Bhaskar, 1979, 1989). Critical realists therefore explain actions as following from mechanisms, or a complex of mechanisms in a particular context, and that such explanations may also be fallible as all actions occur in an open system. In such a situation, one can propose that transformative social learning learning is the outcome of actions that emerge from mechanisms, acting in a particular context. In other words, learning may be informed by the values and powers (mechanism) of individuals or groups in an irrigation system, acting within the activity (context), which has an impact on individual and collective agency and transformative praxis, as shown in the examples of learning outcomes and transformative agency expression development in Chapter Six. Important too, is the understanding that the relationship between generative mechanisms and their effect is not fixed, but contingent, and that this relationship is intrinsically dependent on the context in which the mechanism operates (Maxwell, 2008). For example, the generative mechanisms of poverty and collaborative values (associated with RA 1 and RA 2) affected processes of emerging out of poverty in both of the irrigation scheme contexts differently as influenced by the types of crops and farming practices, but also similarly in particular ways (e.g. precarious income streams).

In Table 7.3 I summarise my reading of some of the key generative mechanisms that shaped the emergence of transformative social learning in the two irrigation systems observed. As noted in Chapter Two, generative mechanisms help to provide in-depth explanation of why things are the way they are. I provide a short explanation of how I identified the causal mechanisms in terms of learning and transformation, and I explain whether the generative mechanisms were activated and under which conditions.

Table 7.3: Interpretation of generative mechanisms

Generative mechanism	Description
Absences and contradictions	*In the Macubulane irrigation association, the farmers were confronted with a decreasing sugar cane yield. The reason was that farmers delayed in fulfilling their commitments to the irrigation system's rules for various reasons explained in Chapter Five (absence of commitment). Thus, the revenue of the association declined, and farmers decided to respond by hiring outside workers to irrigate the fields and control the weeds. This led to increasing yields in the next years. They also learned that by doing so they were exercising solidarity in terms of assisting unemployed members of the community. In addressing absences and constraints, farmers demonstrated new forms of cohesion which are relevant for collective learning. This is in line with what Bhaskar (2008) argued, namely that constraints must be generalised to include the unwanted and unnecessary, and are thus remediable. Absenting absences and, hence, constraints can be liberating, and offers possibilities for self-development and self-realisation and transformative praxis. Other absences are outlined in section 7.1 above and are also identified as being important for informing ongoing transformative social learning processes.*

Self-cultivation	*This refers to motivation of farmers within the idea of self-cultivation, autonomy, and the concern of farmers to practise wisdom. Is important to note that everyone in the irrigation system is a protagonist in knowledge generation about irrigation practices and management processes. Conversation, dialogue, and reflection are part of the learning process. The managers play a relevant role in bringing farmers together to learn. The diversity of the farmers' competencies also motivates farmers to learn irrigation practices. Reports of activities are delivered and discussed among farmers at different stages. The main reason to become part of the irrigation association, is the farmers' hypothesis that they would have water available and be prevented from external constraints, such as drought. Farmers, motivated by this autonomy and self-cultivation, become enthusiastic to be part of the whole process of irrigation activities. Water is the principal motivation for farmers to join in irrigation practices and understand that working in a group reduces risks and costs and that they may benefit from it. The power of this generative mechanism is shown in the data extracts below:* ***Respondent CLWMM1:*** *We have seen other fellows opening an association and earning a lot of money, in the case of Maguiguana association, and we appreciated that, considering that in our own fields there was a problem with shortage of rain. We had trees in between and we could not crop accordingly.* ***Respondent IIMM5:*** *I used to suffer when I was working alone, before being in the association, but when I joined the association it was possible to work together to improve. Alone, I could do something, but in the association I get much… In the association I help my husband with domestic costs.*
Trust	*Trust is concerned with agreed and shared decisions. It is an exercise that is developed within the association and revealed in the level of involvement of the association members. What enabled learning in Macubulane was prior consultation at different levels within the social organs of the association and with relevant members by building community cohesion. Interesting issues in the case of Macubulane were related to the fact that every two years the association runs elections for a new board, according to its statutes. However, members often informally agreed that the irrigation board must proceed with its activities for the achievements of the association. They were confident that the activities in the irrigation system would be fulfilled. Data reported in Chapters Five and Six showed that trust opens fair discussions among irrigator farmers and stimulates the development of new ideas. It also distributes the vision of the association, which is a source of learning.*
Norms, values, policies and learning strategies	*As shown across this study, the introduction of the policy on community-based irrigation scheme development in Mozambique has been a key 'generative mechanism' for the emergence of the schemes. Within this, and associated with each of the specific sites, there are rules, dispositions, values and mandates that have the power to foster transformative social learning processes as noted in the preceding chapters. These include concepts, object problems, and contradictions that provide a source of learning in the activity systems as shown in Chapters Four, Five and Six. The irrigation board could balance the farmers' needs in the association as well as the commitment towards building irrigation agency, including policies that guarantee water delivery following irrigation schedules. Mediated artefacts are very important for learning processes. However, they were not able to influence national policy to provide better safety nets for farmers, nor curriculum change in the education and training institutions.*

Leadership, persistence and appropriate structures for engagement	*The leadership in the case of Macubulane is appropriate in terms of having flexible mechanisms for new ideas that influence perfection, and, hence, changes in association activities. However, it is important to note that effective leadership requires an environment that values reflective practices and critical thoughts, i.e. an environment that makes it possible for actors to transform ideas into actions. The association must foster interactions among farmers to improve commitment of individuals and create a collective basis that should be able to transform new ideas into actions. Leadership is to recognise values that influence the process of irrigation system sustainability.* *Initially, the irrigation board had difficulties to get members to understand the importance of the wide range assembly, but after the association members saw the increased income they became happy with the association board. Before, when the board told them about the need to hire workers from outside, farmers thought that these ideas were a way of the management board taking money from the association. However, the association was confident that such a decision would help all in the association and increase the productivity in the whole irrigation system. Because the income increased in the association, farmers become happy with the management board and wanted them to continue. The persistence of the irrigation board was valuable in this change; however, the wide-range assembly is the relevant environment that makes it possible for the actors to transform ideas into actions.*
Transparency	*In Macubulane, the management board used to present the report of activities in different stages to the wide-range assembly. They discussed issues that were raised during the realisation of activities and how these were solved, and decisions were made regarding allocation of association resources. While the irrigation board presented the activity, the farmers learned the challenges faced by the association and the irrigation board, and how common resources had been used.*
Vision and knowledge	*In an irrigation system, the vision of what a community-based irrigation system is and why it was established and what its object is to be for all farmers, is crucial for enabling transformative social learning and irrigation system development. As shown in this study, an absence of a clear vision and appropriate knowledge hampered the emergence and development of the irrigation schemes. As also shown in this study, this may influence the potential for transformative social learning. The vision and clear knowledge of the irrigation scheme practices, and their management, and beneficiation and sustainability may also foster arrangements in the association and influence the operationalisation of the irrigation system as also shown in this study.*

The generative mechanisms identified in Table 7.3 show that there are a range of generative mechanisms that can influence and shape the emergence of transformative social learning and the irrigation system development process. These generative mechanisms are related to the conditions that drive learning and transformation, and are actually forms of power and structures.

It is interesting to note that national policies and strategies which were identified and mentioned in section 1.3.3 play a relevant role as influencing generative mechanisms at the macro-level, which shapes wider learning in irrigation system development. The two main groups of policies and strategies that stimulate learnnig in irrigation systems are those that are related to agriculture and irrigation development, and education and local resources use.

In this case, absences are a kind of generative mechanism with potential for transformative social learning in irrigation system development, that emerges at micro-level or more locally, but which are related via a system of emergence to more general underlying mechanisms such as changes in policy which reflect government ideology and values.

Considering the two case studies of Macubulane and Massaca, it can be said that, as Bhaskar (1998) noted, even if we have causal powers and its structures are in place, this does not necessarily mean that that things will happen as expected, due to the fact that some causal powers and structures may not be activated, or that they may activate differently in different settings, as, in the open systems of the social world, the same causal power can produce different outcomes (Sayer, 2000).

In the two irrigation systems, diverse cultural histories and socio-material conditions and other related causal powers did not produce the same learning results in terms of transformation. This can be explained by the fact that learning in the irrigation systems was also driven by different materialities in cropping practices: (i) monocropping practice in Macubulane (ii) or mixed cropping practice in Massaca. The differences between monocropping and mixed cropping also make learning distinctive and influence the sustainability of the irrigation systems differently. Transformative social learning in Macubulane was more sustainable than in Massaca in terms of achieving the object of community-based irrigation system practices and management. It seems that the management board of Macubulane irrigation association were better supported by the local sugar company and extension officers, and were also more capable of responding to absences and contradictions through processes of absenting the absences and confronting the contradictions. For example, through the concept of shared risk, they decided to acquire a tractor to clear the fields, organised manpower from the surrounding community to irrigate in order to follow the required schedule, and they were able to practise seed control. All these actions provided more sustainability to the Macubulane irrigation association. However, it is important to know that all farmers grasped the concept of shared risk. In addition, the reasons driving the learning process and transformation in Macubulane irrigation association were related to the (i) method used in the irrigation system (sprinkler); (ii) cropping system (monocropping); (iii) market (outsourcing or not); (iv) the nature of decisions made by the farmers; and (v) the ability that managers showed to deal with absences and contradictions in the association. For example, in the Macubulane irrigation association, learning tended to be more collective value-oriented, enabling the development of better alternatives, identifying opportunities, and articulating and using fundamental values to guide and integrate decision-making activities. This includes reflections on experiences by thinking about and evaluating them (Keeney, 1996). Learning in this association was absence driven, and members of the association were able to transform and resolve absences. Additional features of the driving forces were the fact that (i) there was not much fear, and there were strong trust relationships established; and (ii) there was satisfaction amongst members, who were generally happy with what they had learned in terms of the results they were getting from farming sugar cane, especially when the options for diversification and improved soil management were added to their scope of activities.

In the Massaca irrigation association, it was more difficult to develop and sustain commitment to the new object of community-based irrigation scheme development due to poor leadership, an absence of commitment amongst some of the members which skewed relations and access to land, resources and benefits while producing unequal cost distribution and unequal access to water. In Massaca, individual members were responsible for their own plot activities, and the farmers work independently with the least possible influence of the irrigation board. Symptoms of a lack of trust were visible in the Massaca case, because farmers did not have water in their fields, and farmers were less active in the irrigation activities. The Massaca management board felt desperate and considered leaving because farmers were not collaborating and did not understand the need for active involvement in irrigation management processes. Failed technologies and more difficult forms of access to regular markets and income from the produce also affected the sustainability and commitment to the irrigation scheme development in the Massaca case, affecting the transformative learning potential. This irrigation scheme, while still showing capability for transformative social learning, was more heavily impacted on by structural realities and effects than the Macubulane case. The situation in Massaca is explained by the fact that even if causal powers and its structures are in place, this does not necessarily mean that that things will happen in ways that are expected, because some causal powers and structures may not be activated. However, if causal powers are not exercised, it does not necessarily mean that there is no learning; it means there is learning but the existing learning events may not bring about transformation in terms of changed practice toward sustainability of the irrigation system, as farmers are not innovative in their practices, and are unable to bring new possibilities, and fulfil the learning object.

A crucial implication of this ontology is the recognition of the possibility that powers may exist unexercised, and, hence, that what has happened or been known to have happened does not exhaust what could happen or might have happened Sayer (2000). Thus, it is possible to consider these generative mechanisms in considering the ongoing potential for transformative social learning. For example, it may be possible to strengthen trust relationships, or leadership and knowledge, or capacity for absenting absences in order to catalyse stronger forms of transformative social learning in irrigation system development. The nature of real objects present at a given time, constrains and enables what can happen, but does not pre-determine what will happen. Even if the causal powers are in place, this does not mean that learning will happen in the desired way. As shown in this study, in the Macubulane and Massaca irrigation associations, the transition from rain-fed to irrigation practices was based on similar structures, yet produced different learning outcomes.

Engeström (2008b) considered that issues of authority are relevant in the transformation of objects. However, coordination is not exactly authority, yet the achievement of coordination is a central manifestation of authority, and is linked to dominant modes of coordination, including its tools. In irrigation associations, co-ordinatination processes are mixed between (i) traditional approaches to management and co-ordination, which focus on giving assignments to elected members of the management board and farmers, and (ii) cooperative approaches to management and co-ordination which are based on participatory planning of activities and dealing with absences and contradictions as they emerge.

Engeström (2008b) also maintained that authority is linked to agency. Individual farmers are involved in various agency engagement processes (as outlined above) while trying to cope with contradictions and creation of the new object of activity, new concepts and norms. This results in development of individual agency and building of collective agency as well, as noted in the discussions above and in Chapter Six.

In this study, generative mechanisms are a 'synchronised' term with contradictions. Generative mechanisms are related to reason and the causal powers of contradictions and shape the potential and processes of transformative social learning, which as noted above, manifest in different learning outcomes in the different sites. These differences, as observed in the study, can be sustained by what Sayer (2000) argued. He suggested that objects are, or are part of, structures. As Sayer (2000) explained, structures are "a set of internally related elements whose causal powers, when combined, are emergent from those of their constituents" (p. 14). Whether these powers are exercised, depends on other conditions. For example, in the case of employed workers, whether they need to provide for themselves. When causal powers are activated (i.e. when the technology of the water hydrants works), the results depend again on other conditions (e.g. the kind of context and tools i.e. the trust relationships). Social processes are normally also dependent on individuals' interpretations of one another.

From the above, it is possible to characterise community-based irrigation systems and their management associations as an open system with complex interactions with these open systems being characterised by and influenced by a variety of intersecting, often unpredictable causes. It is also possible to propose that, in considering future possibilities for ongoing transformative learning, it is helpful to consider not only that which is occurring at the level of the actual and empirical, but also those generative mechanisms that appear to be influential at the level of the real.

7.6 Reflecting on dilemmas of learning and agency in irrigation associations

Harvey (2002) stated that agency is related to the transformative negation of social structures, and alters the future conditions of its own capacities by reproducing or transforming social structures. This suggests that there cannot be social structure transformation without learning, and that learning is a condition for social elaboration in society (ibid.).

In section 7.4 above, I discussed the generative mechanisms for learning in the irrigation systems of the Macubulane and Massaca irrigation associations. However, it is important to note that learning processes in these two systems are likely to result in different kinds of agency, as was also shown in sections 6.2.6 and 6.5.7. This is because, even under similar learning circumstances, the learning context, as described above, differs in each association (e.g. mono-cropping versus multi-cropping, sprinkler system versus gravity system; different levels of trust etc.). This enforces different practices and different needs in workplace learning and management processes of the irrigation system. Thus, the power exercised in one context may be latent in the other case and learning outcomes vary.

The reason for this difference relates to the structures that are reproduced through the irrigation systems, which can be described also as the 'agency learning environment' in irrigation systems as agency is shaped by, and changes in relation to structure, and also has power to change structures. Here, according to Bhaskar (1979), the "agent is subject of two types of control: control of negotiation in dialogue; and control of coherence with the rest of agent's behaviour" (p. 93). In Chapters Four, Five and Six, I was able to show that learning can influence the emergence of agency, and that there is a relationship between learning and transformative agency formation.

From this study, it is possible to see that learning and agency formation in irrigation systems is *concept dependent* and concepts drive the (i) irrigation method and practices, especially how these differ from rain-fed practices; (ii) irrigation management types, in the case of this study, the community-based irrigation association management system; (iii) the type of irrigation practices e.g. monoculture or multi-cultures; and (iv) the understandings and meanings of sustainability that are possible in the system. Learning and agency in the irrigation system context is also *activity dependent* and is driven by the need to (i) sustain the system, and (ii) change the social status of farmers. Additionally, learning and agency in irrigation systems is spatio-temporally dependent and is driven by the: (i) institutional history and context creation of the irrigation association, (ii) when, and (iii) where, and (iv) under what policy, social-economic and social-ecological conditions the irrigation system was established.

Learning and agency in the irrigation system is profoundly social, and is dependent on meaning making processes and opportunities, social structural conditions (e.g. power relations), beliefs and values (especially values for collective engagement as was shown above), existing knowledge and experience and cultural habitus (e.g. cultural familiarity with rain-fed agricultural practices), assumptions (e.g. of benefits), methods practised and preferred, and ability to engage with dissonances faced in the specifics of the irrigation practices and irrigation context.

Learning and agency in the irrigation system is also socio-material, and is shaped and influenced by the type of crops / and the physical processes and demands of the agricultural production system, as well as the natural resource base and its sustainability. For example, in the Macubulane irrigation association, learning and agency is concerned with learning monocropping, farmers only need to learn to practise irrigation in relation to one crop (in this case sugar cane) which only involves planting once in five years, after which the sugar cane plant is removed and replaced (it is here where the concerns about soil quality emerge). Learning and agency in irrigation management practices in this context are mostly related to learning how to use sprinkler irrigation practices and technologies, for example, the Macubulane irrigation association uses sprinklers that require considerable manpower. The learning in the workplace is focussed only on this set of relatively standardised practices. Learning facilitators focus only on the one crop and it is probably easier to monitor the learning activities and follow the whole cycle of production.

Learning and agency related to management processes are also influenced by the cultural historical and material nature of the type of agricultural practice. Mono-cropping has the relative advantage of flexibility in controlling the activities. For example, the Macubulane board was able to deduct 30% from what they earn from the sugar cane harvest and use that amount to pay running costs of the irrigation operations and maintenance, pay for herbicides, and service loans at the bank, as reflected in this data extract:

> **Respondent EADMM10:** *We understood that when the production decreases, it is difficult to pay the loans, but when it increases there is no problem, and 30% becomes a lot and we can cope with running costs.*

From the above, it is possible to see that learning and agency formation in the Macubulane irrigation association occurs in a relatively stable environment because they use outsourcing, which means that they sell their produce directly to a specific sugar cane company i.e. their market is secured. Social elaboration of agency and learning in the context of monocrop irrigation as observed in this study, are related to irrigation dilemmas, such as water spillages that occurred in the beginning of the irrigation association's establishment, which were eliminated and replaced with the concept of water efficiency. Thus, by practising monocrop irrigation, learners acquire specific kinds of knowledge and forms of agency that are closely related to the type of cropping and irrigation management practice.

This differs from the learning needed for successful mixed cropping practice (i.e. the growing of vegetables and smaller scale crops in Massaca). In the Massaca irrigation association, farmers practice in a mixed-cropping agency environment and use the gravity method of irrigation. The farmers need additional knowledge in terms of how to plant and manage those different crops to have a good year-round yield. In this case, farmers do not have direct recourse to outsourcing, meaning that they do not have a secure or stable market, the selling of their farming products is not guaranteed and farmers must learn to deal with business issues. The dilemmas are complex, and are also difficult to be resolved at the management level of the irrigation board and, as shown in Chapters Five and Six, they face many constraints in controlling the process, because farmers work independently, so the water delivery is also complicated, even without the technology failures. What they have done is to set a schedule which delivers water in the morning and in the afternoon. In addition, learning and agency also depends on the quality of the irrigation infrastructure. In the Massaca irrigation association, agency was related to farmers who accepted the new technologies; however, as explained in Chapters Five and Six, there were also farmers that did not accept the new farming technologies, and do not rely on what they have learned as they continue to use rain-fed farming approaches in the irrigation scheme context. Farmers still practise seasonal farming in the irrigation system as in the rain-fed system, and farmers still put too many seeds in the same place and argue that some will probably not grow. Thus, farmers have learned new concepts, practices, and technologies, yet they are still attached to traditional agricultural practices, habits, beliefs and practices. Rejecting the technology relates to cultural beliefs, and farmers think that they have more experience in cropping than the young professional facilitator who is advising them.

In summary, the above reactions by farmers are related to (i) the possibility that the learners are unable to understand the meaning of such technology; (ii) failure to understand the relevance of that artefact; (iii) failure to appropriately use the learning methodologies; and (iv) the learning setting and traditional cultural practices and beliefs. All this suggests that there should be a shift in the way curriculum and workplace learning practices are addressed in the irrigation association's practices.

Bhaskar (1979) suggested that a realist explanation of how things occur is that the outcome of an action follows from mechanisms acting in particular contexts. The descriptions above show that the outcome of learning and agency in the two cases was diverse, and was shaped by diverse generative mechanisms acting in the particular contexts. This has implications for making recommendations on furthering the processes of transformative social learning in the context of irrigation scheme development.

7.7 Towards a model of transformative social learning in irrigation associations

In dialectical critical realism, absence is pivotal in the 1M to 4D dialectical relation, meaning that learning and agency occur through identification of absences and contradictions, and the subsequent absenting and addressing of these. Bhaskar referred to this process of learning and agency formation as a fourfold polysemy of learning (which is also a process of emergence), which involves:

(i) Simple absences as products in irrigation associations which include a set of all kinds of constraints, contradictions, unmet needs, inconsistencies, and disturbances experienced by the members in the process of irrigation management, and development of an understanding of these absences and contradictions, which are a source of learning, as also proposed by Engeström's cultural historical activity theory.

(ii) Absenting as process (in the case of this study as transformative social learning process), including the possibilities of simple divergences from the absence, which includes forms of expression, and cognitive and social experiences by farmers while trying to cope with the absences and contradictions. In this study, there was evidence of farmers engaging with this process through deliberation on the problems, seeking resolutions to them, and co-engaged dialogue and trying out of new practice (reported in Chapters Four and Five) to varying levels of success. The expansive CLWs heightened engagement with these contradictions and absences, and allowed for the formation of transformative agency expressions as reported in Chapter Six.

(iii) Absence as a process-in-product, exemplified by existentially constitutive geo-history (i.e. movement towards sustainability objectives in the irrigation scheme object) or intra-active relationality (movement towards solidarity) in which broader visions and concepts are needed for enabling and ensuring the sustainability of the irrigation association and system. In the case of this study this involved processes to ensure that water is to be used efficiently, technologies and strategies to ensure that the system is used effectively, maintained and that productivity can be guaranteed in terms of good yields and regular income streams for farmers. As noted above, this also involved development of approaches to strengthen solidarity in community, trust amongst association members and the board, and ecological sustainability, thus addressing the social-ecological-economic and political dimensions of sustainability. This, in essence, helps to establish the wider vision of the irrigation scheme development. It also included visions of improved education and training quality and relevance, and policy measures that could provide stronger safety nets for farmers emerging out of poverty and engaging themselves in the new irrigation scheme development system.

(iv) Absence as product-in-process, exemplified by ongoing social activity and the practical realisation of agency *in situ*, whether reproductive or transformative. As shown in the study, there was evidence of the transformative social learning process leading to agency, in some cases (as amongst some of the farmers in Massaca) this was reproductive, and in other cases it was more transformative (as in the farmers-association board relationship in Macubulane) in relation to the new object of activity. In terms of sustainability as an expanded object of activity, there is still much to be done in both cases to fully develop agency for transformative praxis.

These concepts are further developed in Table 7.4 where the summary of a polysemic framework for transformative social learning in irrigation systems is developed.

Table 7.4: Summary of a polysemic framework for transformative social learning in irrigation systems

Absences 1M – as PRODUCT (including contradictions analysis)	**Absenting 2E – AS PROCESS**	**Totality 3L – AS PROCESS-IN-PRODUCT**	**Praxis/agency / transformation 4D – AS PRODUCT-IN-PROCESS**
Absences: association constraints and contradictions related to absence of conceptual understanding of irrigation practices, internalisation of learning concepts and practices of irrigation processes and management, adequate mediation tools for learning (contextual) to deal, for example, with externalities, such as farmers not being able to follow the irrigation schedule and control weeds, low efficiency informed by performance of irrigators. Initially risk of reducing association's control over the management process. Externalities and achievement of wider sustainability are still problematic in the process.	Learning through absenting absences and responding to contradictions via ongoing workplace learning, and wider social learning, including expansive learning in CLWs. For example, the general assembly discussed the dissonances and agreed to employ workers to clean and irrigate plots; in intervention workshops, it was put forward that a manual or booklet on management concepts could be developed and that further courses on irrigation and agrarian associativism should be developed. The need for improving rules on access loans, and criteria to access them was also identified via the learning process.	Sustainable irrigation and related concepts and practices in irrigation systems were identified, including structures which encapsulate and support new activities, practices, and bodies.	Cognitive praxis and expanded knowledge and reflexivity was experienced by farmers. There were also some actions that changed aspects of the social status of farmers. New concepts and plans for farming practices were put in place. New learning structures were established (especially valuing of the CLWs as a learning forum) and identification of new courses. Some of the practices resulted in increased yields and wider benefits. Farmers have higher efficiency, more or less start to internalise the concepts and practices of irrigation management. The object has been partly transformed from rain-fed to community-based irrigation system farming.

Based on the findings in this thesis, and on the discussions of these in this chapter, and in order to present a synthesis for considering transformative social learning, I present Figure 7.3 below which provides a structure for an explanatory framework of transformative social learning in irrigation systems. This framework can be applied to other sites to investigate transformative social learning processes, and potentially also has wider applicability beyond the context of irrigation system management. The wider testing of this framework, is, however, beyond the scope of this study. It serves as an outcome of this study.

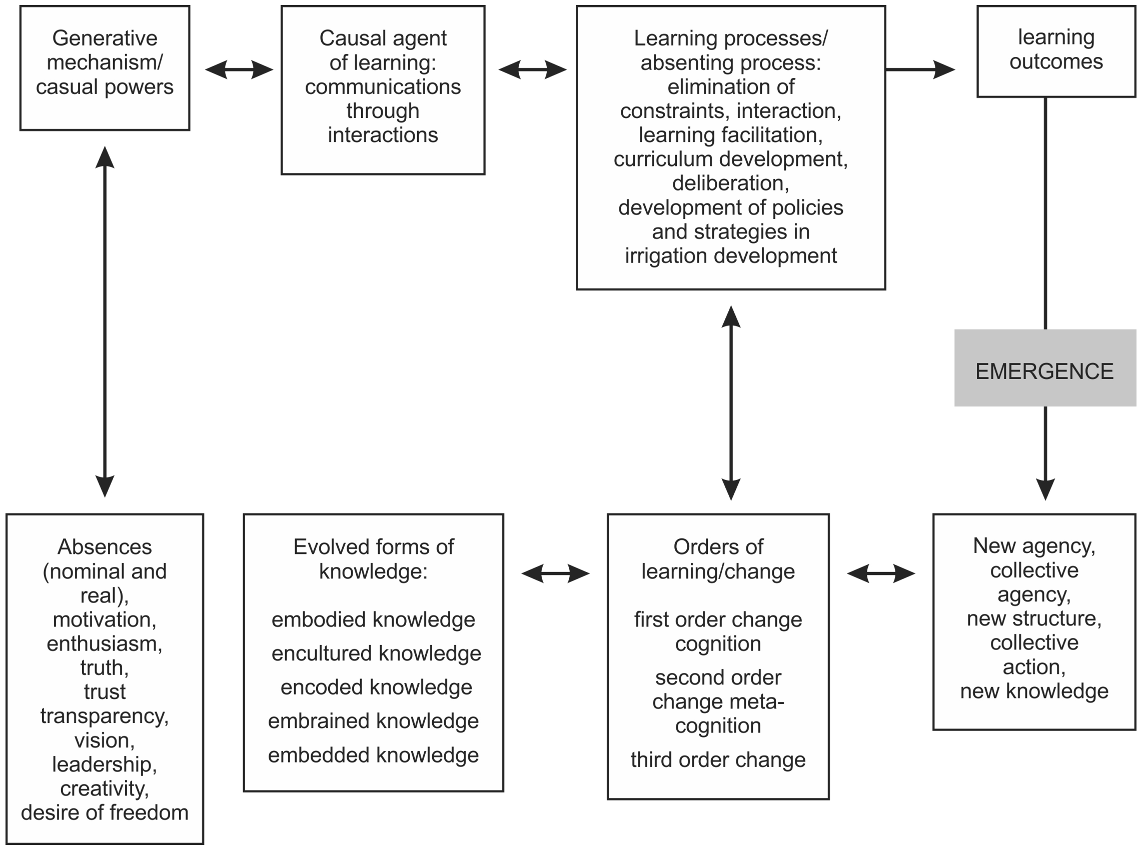

Figure 7.3: Framework of transformative social learning

Transformative social learning is a collective object driven process in the context of a transforming object (from rain-fed to sustainable community-based irrigation scheme farming in this study), that can be explained from the level of generative mechanisms and associated real absences that shape nominal absences and contradictions within and between activity systems. These induce, and have potential to induce transformative learning in irrigation systems, and include the emergence of transformative agency via learning through workplace-based, wider social learning, and expansive learning interaction processes amongst subjects in interacting activity systems.

To be comprehensive, I felt that there are types of terms which work in complex synchronised levels within such a model. These are (i) contradictions, which can create disruption and re-mediation; (ii) absences (which manifest as real or nominal); (iii) emergence which relates to learning outcomes over time; and (iv) generative mechanisms which provide reasons and causes. These synchronised terms when read in relation to Figure 7.3, define and explain transformative social learning.

Transformative social learning processes consist basically of absenting absences and addressing associated contradictions through various learning actions and associated responses. Absence can be described as unmet goals of farmers, if it is considered that the motive to join the association is to have water to irrigate and to improve yields and improve social status in order to move out of poverty. Farmers believed that by joining the association, they would be able to improve their knowledge, change practices, and improve their social status and well-being.

Bhaskar (1998) noted that emergence is something new resulting in new entities, strutures, totality, and / or concepts amongst other possibilities. As can be seen across this study, learning outcomes are related to the emergence of new agency, new structures, collective action, new knowledge, expanded concepts and improved beneficiation, including wider solidarity and sustainability improvements. As noted in Bhaskar (2010) emergence arises in open systems, from the domain of the real, manifesting in changes in events and empirical experiences as was also shown in this study. Understanding emergence therefore requires scientists and researchers to focus on the more basic levels i.e. the level of the real, where structures and mechanisms interact to generate experiences and events. As shown in the two case studies, an irrigation system is an open system, with defined material and social strata, associated events and experiences, and structures and mechanisms that genete them. This study has shown how these structures and mechanisms are associated with the emergence of transformative social learning and associated learning outcomes and possibilities.

In sum, this model shows the interrelated processes involved in transformative social learning which encapsulate a realist perspective on the ontological influences and the emergence of a diversity of social experiences associated with the object transformation from rain-fed agriculture, to sustainable community-based irrigation system development.

> ***Recommendation 1:*** I recommend further testing and application of this model to strengthen ongoing potential for transformative social learning towards sustainable community-based irrigation system development in the context of the community-based irrigation system policy intentions of the government of Mozambique. In this study, I was only able to work with two irrigation sites, but the study shows that there is potential to expand knowledge of the transformation of the object by giving attention to the potential of transformative social learning as a critical dimension of this policy framework.

This model, and the insights gained into farmers' learning around the transformation of the object of activity explored in this study, also has implications for wider curriculum and policy development interventions. As noted in section 7.5 above, the transformative social learning ‘on the ground’ amongst farmers was not able to actually bring about wider policy change, or curriculum development change, although good insight was obtained as to the policy and curriculum development interventions that are needed. I therefore move towards closure of this study by making curriculum development and policy recommendations for wider uptake by policy making and curriculum development activity systems.

7.8 Curriculum and policy development recommendations to strengthen potential for furthering transformative social learning in community-based irrigation scheme development

7.8.1 Curriculum development recommendations

The actual curriculum in place on various courses associated with farming (described in the activity systems analysis in Chapters Four and Five) is mainly concerned with technical components of farming and extention activities. From this curriculum, it was noted that the learning processes promoted via these curricula give less consideration to wider issues involved in the transformation from rain-fed to irrigation system farming. They also fail to take account of different contexts associated with the diversity of farming systems, such as large and smaller production systems, or monoculture and pluriculture farming contexts which may affect the learning process in the irrigation system as was shown in this study. This study has shown that there are specific dynamics of community-based irrigation scheme development and management that cannot simplistically be subsumed into general monocultural irrigation scheme education and training or into technical curricula for such an approach to agricultural development. Therefore, it is suggested that there is need for curriculum changes.

As reported in Chapters Four, Five and Six, various recommendations were made by farmers and participants in the activity systems for improving agricultural education and training. This included offering suggestions on a range of new courses that should be developed, on the relevance of the training on offer, and on the methods of supporting farmers’ learning. All these have implications for curriculum development in the agricultural education and training institutions. However, making recommendations for new courses may not be an adequate curriculum response, as these courses need to take account of the wider processes of learning and change associated with the transformation of an object of activity. As stated by Engeström (2016, p. 39):

> The basic argument is that traditional modes of learning deal with tasks in which the contents to be learned are well known ahead of time by those who design, manage and implement

> various programs of learning. When whole collective activity systems, such as work processes and organisations, need to redefine themselves, traditional modes of learning are not enough. Nobody knows exactly what needs to be learned. The design of the new activity (externalisation) and the acquisition of the knowledge and skills it requires (internalisation) are increasingly intertwined.

As shown in this study, the processes of absenting absences and dealing with contradictions that arise in the transformation of the object of activity, is crucial to understand and explain learning for transformation in irrigation systems. As shown in this study, this invovles collective processes of absenting absences and responding to contradictions through the processes of constraints elimination, solution development, learning facilitation and deliberation. Such processes take place in daily management meetings, meetings with stakeholders, meetings with extensionists, and in interactions with local authorities. Substantial learning also occurs during the wide-ranging meetings that involve all members and the management committee. Here I want to agree with what Sterling (2011) noted "that learning for sustainability must transcend the traditional transmissive learning approach [...] because information alone does not necessarily lead to change" (cited in Boehnert, 2012, p. 103). Wals (2009) also emphasised the shift from individual to collective forms of learning in education for sustainability as follows: "by explicating and deconstructing the oftentimes diverging norms, values, interest and constructions of reality people bring to a sustainable challenge.....not only becomes a possible roots to analyze and understand their roots but also begin a collaborative change process for sustainability".

Thus, for curriculum development, it would seem that an approach that allows for in-field engagement with contradictions and the absenting of absences (a problem-based type of curriculum), and which allows for conceptual development and understanding of the changing object of activity (i.e. community-based irrigation scheme *practice* and *management*) is needed. Concepts are not only technical, however, as I found in this study that there is evidence of different types of organisational knowledge of farming and management which include:

(i) *Conventional technical-practical knowledge and concepts*: In irrigation schemes this knowledge is related to the processes of farming and managment practices, and is aimed at improved farming technologies in the field. Such knowledge has to do with the types of crops to plant under irrigation, how to manage resources distribution, how to monitor activities in the irrigation system, processes of operation and maintenance of the system, ecological system knowledge, and knowledge of finances, technologies and markets.

(ii) *Social knowledge and concepts:* In irrigation systems, this knowledge has to do with how actors work together in the irrigation system, and in managing the irrigation scheme under and associative or collective framework. It includes understanding social processes, issues of mutual beneficiation, and collective values development, and concepts such as solidarity, fairness, trust and leadership. It also involves consensus seeking, and conflict and contradictions management in the irrigation system.

(i) *Traditional knowledge*: Where the farmers use the knowledge they have from the past to guide their farming practices, and in the managment of the irrigation system. As shown in this study, traditional knowledge may also need to be challenged under the transformation of the object of activity.

Thus, any curriculum development should take account of not only the *engagement in the formation of collective activity*, but also *the diversity of forms of knowledge* associated with the formation of the activity. Additionally, curriculum development should also take account of the need for *reflexivity*, as this was found to be an important process which helped farmers to address contradictions and absent absences, and to learn, as shown by these extracts from the data which show evidence of the types of reflexivity found in the study amongst farmers:

> **Respondent CLWMB2:** *We know now that we should not misuse water, because it must be saved.* [reflexivity related to sustainability practices]

> **Respondent CLWMM12:** *The risk that we have is fire. If someone does fire in the sugar cane field, we all will lose our production.* [reflexivity related to risk management]

> **Respondent CLWMM 4:** *It is always good to learn and work in a better way. For example, now we know how to irrigate. We did not know that before. We know that we have to change the field areas in some periods, putting a lot of water in the fields is not good. This means we are learning a lot of things and open our minds.* [reflexivity related to expansion of own knowledge and learning]

> **Respondent CLWMM12*:*** *It is important to develop research on how after harvesting the sugar cane we can produce beans.* [reflexivity related to the need for research and generating new knowledge to inform practice]

> **Respondent FGMB5:** *When we are working, we need to work and understand each other.* [reflexivity related to collective action and relations]

> **Respondent CLWMM5:** *We work by understanding each other, and because we work together and as a group the government, international institutions they have been seeing how we work, and they come together to support our association, and our success could not happen if working alone.* [reflexivity related to the collective association system]

> **Respondent EDAMM2:** *When we see things destroyed, I feel the need to help and fix it.* [reflexivity related to ethics and moral concerns]

Respondent EDAMM1: *In the beginning we had a yield of 20 000 ton. In the next years, we harvested 24 000 ton and the next year 17 000 ton. We realised we were in the red light and we called for the wide-range assembly to present the problem […] then we decided to improve our work by accepting or hiring outside workers from the community for irrigation. We then started to have an increase in our sugar cane harvesting, and the members doubled their profits from 30 000 to 60 000 MZN.* [reflexivity related to the production system and benefits]

This reflexivity shows that farmers, while engaged in transformation of their object of activity from rain-fed to irrigation scheme development, are challenged with constraints at managerial, financial, technical, social and organisation development level, all of which require reflexivity (as shown by the examples of reflexivity outlined above). Overall, this offers a message to curriculum developers who are working on curriculum develompent for community-based irrigation scheme development that curriculum development is not simply a process of defining and transferring content, but it should allow for learners to engage critically and reflexively with changing practices where possible. As stated by Engeström, Puonti and Seppanen*,* (2003, 151-165), *"*singular change is not made by singular situations, but in the interlinking of multiple situations and actors accomplished by virtue of durability and longevity objects" which indicates also the longer term nature of the reflexive process. In this study, transformative reflexivity can be seen to be concerned with the process of identifying the contradictions reflected in the decrease of production, and inefficiencies in the system and its emergence, and identification of the related reasons. As shown in Chapters Four, Five and Six, these contradictions are quite common in the emergence of the community-based irrigation system development process. Curriculum developers could therefore potentially consider some of these contradictions as sources of learning for students. This would also mean that the curriculum cannot be static, but should be closely linked to the emergence and realities of farmers' practices.

Lastly, curriculum development needs to take account of *the systemic nature* of the transformation to community-based irrigation scheme development. As shown in this study, intervention workshops were developed in the Macubulane and Massaca irrigation associations. Farmers and irrigation practitioners were involved and the workshops included follow-up meetings to assess transformation in the irrigation associations. In both cases, this work-oriented pedagogical approach indicated that engagement within and with the systems of activity is a powerful stimulator or catalyst for expanding learning. As also reported on in Chapters Four, Five and Six, the process was based on identification and reflection on contradictions in the irrigation association, which included *both* longer term cultural historical contradictions and those that arose during the intervention workshops (i.e. situated within the cultural-historical system). In this case, the unity of transformation was in terms of management practices. Concept formation included emerging understanding of the concept of irrigation systems and management, which can be described as a socio-ecological system, relying on interconnected sets of activity systems, and binding understanding on how to operate the irrigation system to achieve sustainability.

Learning products included the creation of new activities. It is important to note that at some stage in the process, the learners took over the control of the process in terms of being actively involved in the learning activity. The learning outcome was the subject of reflection and diffusion in the wide-range assembly of the irrigation association, indicating the scope of *the social systemic* nature of the activity formation. The most important outcome of the expansive learning was agency – participants' ability and will to shape complex activity systems, such as the irrigation activity system within this systems perspective and context.

> ***Recommendation 2*****:** Based on the above, and the findings of this study, I recommend an approach to curriculum development that moves beyond a transmission approach to an approach that will support reflexivity and engagement in transforming irrigation system activity. As Engeström and Sannino (2010 P. 5) has noted, this involves "descending from the abstract to the concrete", and involves engagement of students in the real world of praxis. Curricula should give attention to the scope of knowledge needed in irrigation scheme development, *as well as* the problem-based learning approaches for dealing with contradictions and absences. Learners should be exposed to, and supported to engage with real contradictions in irrigation scheme development, to allow for reflexivity development and changed practices.

> ***Recommendation 3*****:** One of the main recommendations proposed by this study, as informed also by the irrigation system actors in this study, is to introduce a module or courses in **Associative Irrigation** into the education and training system in Mozambique, with a focus on the learning needed for transitioning from rain-fed to community-based irrigation association practices. This should include all the management practices that are needed for this type of irrigation management and should be based on the approach outlined above. Based on the analysis of the activity systems in this study, I would recommend that the curriculum be developed to address the learning interests of facilitators and extension officers, farmers, irrigation board members, and formal education and training institutions. This may require a specific

- Learning curriculum for facilitators
- Learning curriculum for farmers
- Learning curriculum for irrigation board
- Learning curriculum for formal education (institutes and universities).

This may take the form of either a course in formal education at secondary and tertiary level using a more structured curriculum framework, and a more informal change laboratory workshop type of process when working with farmers. It is, as noted above, important to maintain links between these actors as it is via the interactions within and between the activity systems, that a systemic understanding of associative / community-based irrigation can develop.

***Recommendation 4*:** Based on this study, and the insights and understanding that I have developed into irrigation scheme development I propose the following broad curriculum framework (see Table 7.5) as starting point for development of the above modules on associative irrigation.

Table 7.5: Curriculum framework for associative and community-based irrigation system development

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General Principles:

- Support a systems understanding
- Focus on technical, social, traditional and other relevant forms of knowledge
- Adopt a problem-based approach which addresses contradictions and absences
- Support reflexive competence development via descending from the abstract to the concrete (i.e. engagement in the field of practice via work integrated learning, internships or other strategies)
- Support values of collective agency and associative practice, as well as sustainability, solidarity and risk reduction.

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<tr><td>Some of the aspects of content to be considered</td><td>Learning cycles and forums to be considered</td><td>Learning orientation</td></tr>
<tr><td>

- **Social-ecological context** of irrigation system: e.g. soil, water cycle, geology, what crops are best for certain conditions and productivity, topography implications, water efficiency; crop water requirements, types of crops and their social-ecologies
- **association knowledge:** e.g. what it means to be an association, association laws and mandates, institutional arrangements and roles, leadership, activity systems interaction, outsourcing and ownership
- **Technical issues:** e.g. crop management, operation and maintenance of the system; marketing strategies, production planning, mechanisation and equipment
- **Financial management:** credit contracts management, cost-benefit analysis, running cost management, savings and loans management, beneficiation options
- **Sustainability oriented knowledge**: environmental risks management, crop harvesting conservation, organic agriculture, solidarity, monocropping vs diversity

</td><td>

- Management board consultations. General assembly meetings
- Conflict resolution meetings
- Gatherings with stakeholders
- Demonstration practices in the field
- Meetings on the perimeters
- Intervention workshops (CLWs)
- Routine evaluation practices
- Facilitation practices in cropping management

</td><td>

- Praxis oriented, involving engagement in new activity formation involving agency
- Change oriented and transformative
- Focus on the transformation of the object
- Reformulation of rules, organisational structure, routines, values, and artefacts to meet requirements of the transformed object
- Changes in values to include associativism and solidarity
- Cultural respect, but also challenge of existing cultures and traditional practices
- Reflexivity
- Identification and elimination of constraints, absences, inconsistencies
- Open-process learning structures
- Sustainability oriented

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7.8.2 Policy recommendation

As noted in Chapter One (section 1.3), Mozambique has a history of different irrigation systems which were inclusive of the pre-independence period and the post-independence period of which the most significant recent policy development intervention was the establishment of the National Irrigation Strategy (GoM, 2013). As noted in Chapter One, one of the achievements of this policy is that it encourages smallholder irrigation producers and considers them a key actor in the irrigation sector. The policy also pointed out that various stakeholders have responsibility for supporting the development of smallholder irrigation scheme development. The Strategic Plan for Agricultural Development (2010-2019) (PEDSA) proposes the need for interventions and support that can support the transition from rain-fed low productivity to more competitive and substantive productivity systems, including co-operative, community-based production using irrigation schemes. As noted in Chapter One, all of these policies mention education, training and extension support that should be provided to farmers, but do not provide detail on the nature of the transformative learning that is required in these processes. This study has shown that with greater attention to the *how* of the transformative social learning, especially via further change laboratory workshops with farmers and interacting activity systems, and via expanded curriculum development, further gains can be made in this transition. The study also identified the need for a safety-net system for farmers engaging in this process who are also emerging out of poverty. The recommendation below is also informed by the analysis above which suggests that policy is an important generative mechanism for social learning.

> ***Recommendation 5***: From a policy implementation perspective, I therefore recommend further investment in the processes of support provided to farmers, as outlined in the transformative learning process framework and curriculum development framework outlined in the sections above.

7.9 Conclusion

This research aimed to understand transformative social learning within the development of sustainable irrigation practices in the context of irrigation associations and new agrarian policy and development in Mozambique. To achieve this I have (i) examined how and what kind of transformative social learning has (or had not) emerged in existing activity systems to date (Goal 1); (ii) examined how transformative social learning could have emerged through expansive learning processes (Goal 2); and (iii) identified what opportunities exist for ongoing transformative social learning (Goal 3). I relied on Activity Theory and Critical Realism Philosophy to examine and understand learning processes and transformation in irrigation systems. The study was undertaken in two irrigation associations of Macubulane and Massaca in the Incomati and Umbeluzi river basins.

The nature of the study was qualitative and was based on applying cultural historical activity theory using the formative interventionist methodologies of expansive learning. As a formative interventionist researcher, my role in the study was to stimulate learning for transformation in two irrigation associations. As can be seen in Chapters Four, Five and Six, in this role, I created space for a broader understanding of irrigation association systems, its object and function, activity systems, and its relationship and implication. My role was to reflect for the learners on the workplace and social learning within the history of the associations. I played a role in the identification of potential contradictions in the irrigation associations via the use of mirror data, and I inspired learning to reflect on these contradictions in such a way that learners had tools and/or develop tools and knowledge to face those contradictions in the processes of irrigation management. In the expansive learning formative intervention, I also stimulated expansion of understanding of irrigation concepts amongst participants which was catalytic for the process of solution modelling, and the emergence of transformative agency. In the Macubulane irrigation association, members were impressed by the change laboratory workshops and appealed for systematic provision of learning practices in the association. They believed that this may improve irrigation practices. In the Massaca irrigation association, learners were actively engaged in the expansive learning dialogues, and in most cases, they drove the discussion by trying to understand contradictions and what to do. They were also able to expand their concepts of the irrigation system and how it works, and provided new tools and approaches for transforming their object of activity.

Further interpretation of these engaged interventionist processes is included in Chapter Seven (this chapter) through a critical realist process of examining the absenting of absences and analysis of the generative mechanisms of learning in irrigation systems and learning agency. This approach allowed for an in-depth reflection of the irrigation practices and management, of contradictions as sources of learning, and helped to produce more insight into the further potential for transformative social learning in irrigation system development. It led to the development of a model for guiding further research on transformative social learning and to curriculum and policy recommendations.

Overall, this study aimed to contribute to understanding and building knowledge regarding irrigation practices in the context of an association, the causal powers of learning, agency creation for sustainable irrigation associations, and, therefore, contribute to framing Transformative Social Learning

Theory. The study contributes to the understanding of learning practices in Environmental Education and Natural Resources Management.

The study showed that:

- Transformative social learning is goal oriented and involves engagement within the processes associated with transformation of the object of activity, both in conversation and materially (e.g. in the artefacts). In this study, the object being transformed was agricultural practice – from rain-fed to associative or community-based irrigation scheme farming. Within this, an irrigation system implies a set of activities systems that have interconnected shared goals within the irrigation association, which include (i) increased yields, (ii) efficiency and efficacy of the system, (iii) social benefits, and (iv) sustainability goals.
- Transformative social learning in irrigation systems can contribute to processes that are oriented towards sustainability and disruption of the poverty cycle;
- Dialectical contradictions and absences are sources of learning in irrigation systems, and learning occurs through a process of addressing contradictions and absenting absences; the contradictions and absences are a source of change or transformation, giving attention to both nominal and real absences and generative mechanisms can deepen an understanding of the transformative nature of the learning;
- Learning strategies include workplace learning, social learning and formative intervention workshop-based learning. This also includes extra-curricular activities, and other research goal activities, such as visits to the field, development of experiments in the irrigation system involving farmers and relevant actors within activities systems. Learning strategies do not, however, exclude learning from formal courses, and a demand for these exists in tandem with the other forms of learning.
- Transformative social learning is a type of learning that encourages engagement in transformative praxis, formation of transformative agency, and that keeps farmers reflecting and reflexively engaging after the learning process. Such reflection is focused on what they are doing, how they are working together, and the meaning of their activities, rather than simply doing things differently, i.e. object oriented learning.
- Collective actions in an irrigation association include collective mediation, implementing new concepts, and collective reflection on ongoing activities. This involves new collective agency development, which involves new ways of doing and understanding how things work, such as water distribution, reframing the water supply schedule etc.

- Social elaboration of knowledge in irrigation systems is concerned with the (i) concepts formation, (ii) new practices, (iii) sustainability learning, (iv) premises reflection, and (iv) irrigation agency. Learning is value-focused in collective irrigation systems, in which new alternatives, relations and practices are formed.
- Transformative social learning occurs at an individual level, group network level, and society level as shown in Figure 7.4.

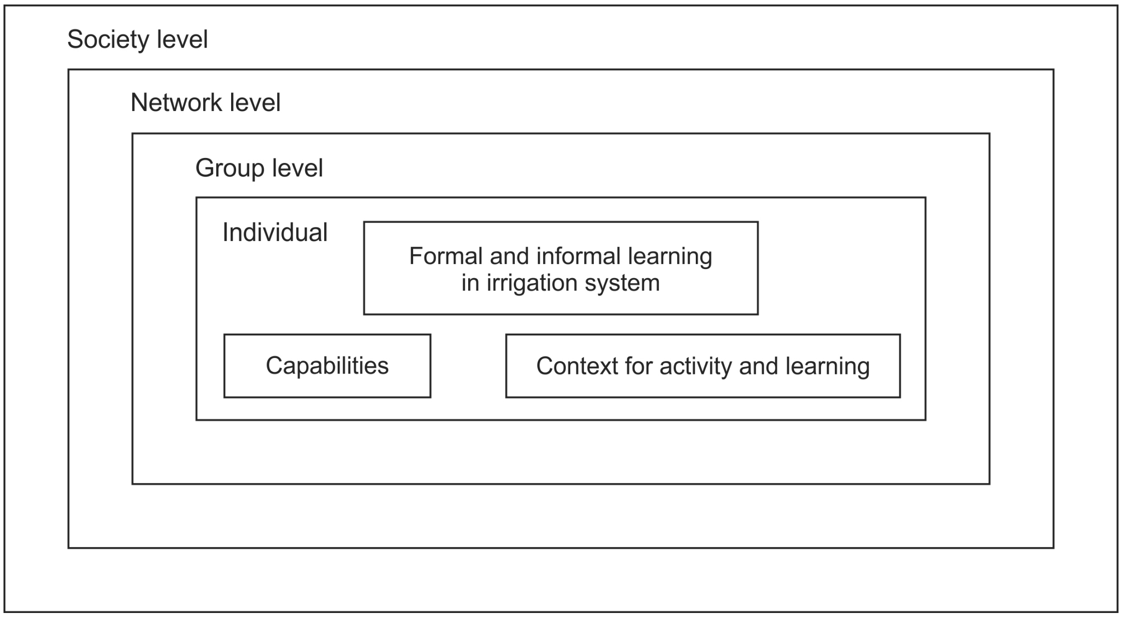

Figure 7.4: Learning context in irrigation system

- Ontological changes require practical agency (focus on constraints of knowledge), which entails moral and epistemological knowledge that informs it (Norrie, 2010), and when there is a process of elimination of constraints and absences, there is potential for the creation of new structures and rules.

As mentioned, while there are studies on irrigation scheme development, I found almost no evidence of studies that concentrated on transformative social learning in community-based irrigation system development in a southern African context, or analysed these using the methodologies of this study. The findings of this study may potentially inform scaling to other irrigation systems but this should be done critically and should not ignore the fact that that each irrigation system has a specific context in tems of its establishment and object of production (amongst other issues). Thus, it is the process results and analytical tools of this study that could be particularly useful for supporting transformative social learning in other contexts. Lessons drawn from this study may therefore be useful to strengthen learning in irrigation systems around the country, especially in the context of the policy shifts to community-based irrigation scheme development.

As shown in this study, transformative social learning theories are still not well understood in the context of irrigation system development, and this study has contributed knowledge to this field. Additionally, it has added perspectives on how to frame transformative social learning from a CHAT and critical realist perspective in Education for Sustainable Development. The study also contributes to a growing body of scholarship in southern Africa (Mukute, 2010; Pesanayi, 2016; Masara, 2010; Kachilonda, 2014) which seeks to develop expansive, transformative social learning approaches in response to concerns experienced by communities who are reliant on natural resources and the environment for their livelihoods and well-being, and who are also seeking to emerge out of poverty.

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Appendices

Appendix A

Appendix Ai

25 February 2011

Meeting with management board

List of Participants

- Sofia Cuacua
- Chongo
- Macome
- Natalia Muchave
- Francisco Muchave

Appendix Aii

4 June 2012 Individual interviews

Code IIMM: Individual Interview Macubulane

Participants

Name	Position	Codic
David Mangueia Cossa	First vowel	IIMM1
Afelicia Muchave	Memberof Association	IIMM2
Massango	First vowel	IIMM3
Zulmira	member	IIMM4
Sofia Cuacua	President and member of association	IIMM5

Appendix Aiii

13 December 2012 Focus group

List of participants:

Code: EADMM= Day by Day Activity Macubulane

Name	Position	Code
Chongo	treasurer	EDAMM1
Anacleto Massango		EDAMM2
David Cossa	First vowel	EDAMM3
Macome	Vice-president	EDAMM4
Sofia Cuacua	president	EDAMM5
Francisco Muchave	Water supplier pumping machine manager	EDAMM6
Francisco	Extensionist officer Macubulane	EADMM7
Natalia Muchave	Member of association	EADMM8
Sarmento	member of association	EADMM9
Balane	member of association	EADMM10
Victoria Timane	member of association	EADMM11
	member of association	EADMM12

Appendix Aiv

9 -10 May 2013 Change Laboratory workshop

List of participants

Code: CLWMB= Change laboratory Workshop Macubulane

Name	Position	code
Natalia Muchave	Secretary	CLWMM1
Luis Muchave	Membro reformado da Esola P.C. de maguguana	CLWMM2
Armando Aguiar Cossa	Secretario do bairrro 4 Maguiguana	CLWMM3
João Chongo	Tesoreiro	CLWMM4
Afelicia Muchave	Member	CLWMM5
Sofia Cuacua	Member and President of association	CLWMM6
David Mangueia Cossa	Member and first vowell	CLWMM7
Joaquim Macome	Member Vice-President	CLWMM8
Rita do Carmo Esaú Cossa Cavele	Extensionist SDAE -Magude	CLWMM9
Gil Alfeu Chauque	Teacher at Professional Scholl of Magude	CLWMM10
Ananias Cossa	Member retired of CFM	CLWMM11
Arão Francisco Manhiça	Member	CLWMM12
Farias Rodrigues Cossa	Member and electrecist	CLWMM13
Patricia Machava	Member	CLWMM14
Jose Vasco chauque	Teacher and Director of Primary Scholl	CLWMM15

Appendix Av

26 October 2013 & 15 March 2014 follow up workshop

List of participants

- João Chongo
- Sofia Cuacua
- Luis Muchave
- Afelicia Muchave
- Anacleto Massango

Appendix Avi

14 February 2011

Focus group with association management committee; meeting with association board

List of participants:

- Bernardo Armando
- Rita Waite
- Sandra Armando
- Tomas Chauque

Appendix Avii

7 February 2013

Focus Group In depth interviews to access activities and practices, individual stories in irrigation association

List of participants:

Code FGMB: Focus Group Massaca Association

Name	Position	codico
Bernardo Armando	President	FGMB1
Silva Cardoso	SDAE - Boane	FGMB2
Rita Waite	Member	FGMB3
Lúcia Alberto Chiure	Member	FGMB4
Chauque	Vice-Preident	FGMB5
Manuel Mussana	Member	FGMB6

Appendix Aviii

7 February 2013 Focus group with association management committee, farmers, CIDAE, Agrarian Institute

List of participants

Code FGMB: Focus Group Massaca

Name	Position	codico
Bernardo Armando	President	FGMB1
Silva Cardoso	SDAE - Boane	FGMB2
Liloca Amone Matola	Member	FGMB3
Elisa Chaiwisse	Member	FGMB4
Rita Waite	Member	FGMB5
Manuel Mussana	Member	FGMB6
Lúcia Alberto Chiure	Member	FGMB7
Sandra Armando	Secretary and treasure	FGMB8

Appendix Aix

2 - 3 May 2013 Change laboratory workshop

List of participants

code CLWMB Change laboratory workshop Massaca

Name	Position	code
Anastancio Mauricio Macaringue	Member	CLWMB1
Rodrigues Matsoo	Member	CLWMB2
Pinto Larce Mate	Vowel	CLWMB3

Appendix Ax

28 October 2013 and March 2014 follow up workshop

Massaca irrigation association

Participants

- Bernardo Armando
- Sandra Francisco
- Lucia Chauque
- Tomas Chauque
- Pinto Mate
- Manuel Mussana
- Elisa Chaiwis